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Original Articles

STANDARDS FOR ORTHODONTIC MATERIALS*

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INTRODUCTION

RESEARCH on dental materials has been in progress at the National Bureau of Standards for a number of years. Since April, 1928, the American Dental Association has actively cooperated in the research. The theme of this program[1] from its beginning in 1919 has been: "Better materials and better technics." Remarkable advances in many branches of dental service have been made as the results of the research have been announced and applied.

THE ORTHODONTIST'S INTEREST

The orthodontist has shared in these advances, as some of the results are specifically applicable to his problems. One of the greatest values to the profession came with the introduction of definite descriptions and terminologies for qualities to be used in measuring and defining the properties of alloys used by dentists. About ten years ago a successful orthodontist, in lamenting over his difficulties, stated that he was able to use less than 20 per cent of the arch wires supplied by the manufacturer whom he regarded as the best manufacturer in the world. By a special arrangement he used one or two wires from each lot of twelve ordered and exchanged the remainder for new material. He wanted a strong, stiff, and nonbrittle wire but was unable to specify a definite standard against which the manufacturer could test his material.

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STANDARDS FOR WROUGHT ALLOYS

With the advent of a definite terminology and the development of instruments suitable for the accurate measurement of essential properties there followed quickly decided improvements in the general quality of gold alloys available for the discriminating orthodontist. The following values[2] are representative for the alloys used by the orthodontist ten to fifteen years ago:

Ultimate tensile strength	90,000 to 150,000 lb. per sq. in.
Yield point	70,000 to 100,000 lb. per sq. in.
Elongation	0.5 to 10 per cent in two inches

As these alloys were improved, it was quite natural for the orthodontist to select more satisfactory wires. All leading manufacturers will now supply, if requested to do so, wires having the following qualities, which represent part of the standard[3] adopted by the American Dental Association:

Ultimate tensile strength	150,000 lb. per sq. in.
Yield point	125,000 lb. per sq. in.
Elongation (hard)	4 per cent in two inches
Elongation (soft)	15 per cent in two inches

(All values are minimum values.)

In rating eight wires which were submitted in 1928, as the best available at that time, I find that not one of the eight would have passed all three of the minimum requirements stated immediately above, although each wire would pass one or more of the requirements.[2]

Today the individual producers of these eight alloys can supply materials meeting all items included in the above high standard without difficulty or extra cost to the orthodontist.[3] You may be surprised to find that the precious metal content of the present-day wires shows a decided grouping in the region of 75 to 80 per cent gold plus platinum metals, whereas many of the older alloys ran from 10 to 15 per cent above these values. Except for the revaluation of gold we should find the best present-day alloys cheaper than those lower quality alloys used ten years ago.

The advantages of heat treatment[3] for arches and springs are being realized by a few orthodontists, who demand the maximum of materials. Forty to 60 per cent improvements in strength and decided advantages against brittleness in shaping springs are readily obtained by simple heat treatments such as quenching in water, heating in a special salt bath or slow cooling in an oven. This subject will be referred to again later in the paper.

Tarnish tests for dental gold alloys have been developed and are of interest to the orthodontist. Certainly the appliance would not be seriously impaired in strength by a simple stain or tarnish, but no member of this Society would want his name mentioned in connection with a tarnished appliance. The 75 per cent precious metal content demanded by the specification is a safe insurance against tarnish. An accelerated tarnish test can be made by placing a wire or band in the vapor of an ammonium sulphide solution.[4]

BASE METAL ALLOYS

This discussion of tarnish naturally introduces the subject of base metals for use in the orthodontist's practice. No one will deny their value where better materials are not available. Many patients can testify to the effectiveness of German silver appliances. The stainless steels and similar alloys have recently been presented for the approval of the orthodontist. Their stainless quality and their resemblance to platinum, a relatively costly element, have in most instances been their chief support. With the present enhancement in the price of gold we may find the light or platinum color prized less highly in the future. Now, if we assume the stainless steels to be as resistant to tarnish as the gold alloys, we have left for consideration their ratings on mechanical and constructional qualities and the relative costs of the gold alloys and stainless steel alloys. Obviously the gold alloys are many times more costly. On the other hand, they do have an attractive value when sold as scrap metal. On the ease of construction and mechanical properties the gold alloys are unique. They solder readily and, as we have seen, have high proportional limits which is the factor of greatest importance to the orthodontist. Yield point as translated into the simplest dental language represents the maximum stress a wire or spring will support or maintain without suffering permanent distortion. The specification demands 125,000 pounds per square inch as the minimum acceptable for dental appliances. The corresponding figure for stainless steel is usually regarded as much less than this value. Attempts at welding or soldering these base metal alloys have presented considerable difficulty. No great amount of time has been spent at the Bureau on these base metal alloys as likely substitutes for the noble metal alloys used in dentistry since they do not appear to possess any superior physical properties and do possess some definitely inferior properties.

Lain[5] raises a question regarding the use, in dental restorations, of metals which are widely separated in the electromotive force series. He reported 213 out of 300 cases investigated as suffering from various lesions apparently resulting from the dissimilarities of metallic restorations. For example, he reports cases of galvanic shock, severe pain, irritation and erosion of the tongue from amalgam fillings associated with gold inlays and gold bridges in the same mouth. The use of stainless steel for arches, partial dentures or similar purposes in mouths in which gold inlays are located, should be carefully controlled and observed to be certain that no galvanic lesion is produced. The same precaution should be observed by those using the stellite restorations. Stellite is composed of chromium, cobalt, and iron. These three elements are likewise widely separated from gold in the electromotive force series of the elements. Fortunately the orthodontist sees his patients frequently and seldom encounters bridges or inlays. The average orthodontist may never meet with this source of danger.

FEW DIFFICULTIES ANTICIPATED

In concluding our discussion of the gold alloys available for use in orthodontia, I believe we are safe in assuming that few difficulties need be en-

countered here. If the operator is having trouble in obtaining a satisfactory arch or spring, he may properly inquire whether the wire he is using meets the specifications approved by the American Dental Association. If it does meet these specifications, the next inquiry should be more personal and should concern his technic in using the wire. It is never safe to predict limits in advancements, but I shall indeed be surprised if any decided improvements in physical or chemical properties of these alloys are made in the near future.

DENTAL CEMENTS

If we turn now to the cements and consider those you have been using during the last five years, we shall see many opportunities for improvements. I realize that the solubility of a cement in mouth fluids is not so important to the orthodontist as it is to the crown and bridge operator. If a band comes loose through the disintegration of a cement, the orthodontist is delayed, but there need be no loss of one or more teeth, as may happen from an unnoticed leak around a bridge abutment. The 1934 survey of dental cements[6] showed disintegrations ranging from 0.14 per cent to 13.7 per cent in one week when immersed in distilled water. The specification[7] for dental cements rejects any cement having more than 1 per cent disintegration. Size of particles is likewise of minor importance to the orthodontist; some cements contain particles approaching 0.1 mm. in length. These pieces of frit should have been screened out and discarded or reground to smaller dimensions. The inlay specialist knows the havoc played by these large particles.

There are, however, two items on cements in which the orthodontist is interested. These are setting time and retention. The lack of uniformity of cements, and indefinite instructions for mixing which formerly accompanied some cements, permitted the dentist to make mixes varying in time of set from, say five minutes to one hour or more, depending upon the cement selected and the method of mixing adopted by the operator.

NEED FOR A SPECIFICATION

Through a cooperative study of dental cements, made by members of the American Dental Association located in several states throughout the nation, it was discovered that cements of the same trade brand were far from uniform in their reactions. It was quite obvious that many manufacturers were not producing uniform cements from day to day. Furthermore it was discovered that dentists throughout the nation had decidedly differing ideas on how cements should be mixed. This field was surely in need of standardization. Those who follow the reports of the cooperative research know that the remedy has been prescribed and is being accepted with decided enthusiasm by a number of the manufacturers of dental cements. The approved specification will be in full force after July 1, 1935. The product must then be up to the uniform and high standard demanded by the American Dental Association and must be accompanied by definite directions for mixing and using. Many firms are now in position to certify and guarantee their product to meet this high quality standard. I am sure the orthodontist will observe and ap-

preciate this part of the research which has smoothed out one of the most chaotic and uncertain situations associated with dental service.

RETENTION BY CEMENTS

A word about the retention of bands attached to teeth by cement should be added to this paper. We have heard much about the adhesion of cement to a tooth or a band. Stickiness has been attributed to the zinc phosphate cements. The research associates conducted experiments[7] in which smooth ivory surfaces were cemented together and allowed to set. After several hours in contact with water the surfaces were separated by pulling. The adhesion was practically zero.

They next made a taper plug and fitted it to a taper collar in an attempt to duplicate an inlay or crown attached to a tooth. The plug was about one-half inch in diameter and three-quarters of an inch long. The taper approximated that used for a compound inlay restoration. The plug and collar were made of polished steel. The plug was gold plated. The plug was cemented in place and after twenty-four hours was pulled out by the exertion of about 1,000 pounds tension. This test appeared to contradict the one made on the flat ivory surfaces. The plug and collar test was repeated, using cement powder and water only. The same tension (1,000 pounds) was required to separate the plug from the collar. This showed the retention to be due to mechanical interference of the granular particles. Thus the picture of the retention of a band on a tooth must include surface folds, irregularities, or bell shapes on the tooth. It is evident to all orthodontists, and has been for years, that slight irregularities in the surface of the band aid in securing a firmer anchorage.

ABSTRACTS OF SPECIFICATIONS

I have referred to the specification for wrought alloys and their heat treatment and feel that it would be worth while to give here an abstract of the specification of these alloys,[3] also an abstract of the specification for zinc phosphate cements.[7] Those interested in the complete specifications and details to be observed in testing should consult the original articles.

TABLE I

REQUIREMENTS FOR DENTAL WROUGHT GOLD ALLOYS
(ABSTRACTED)

GOLD AND PLATINUM GROUP METALS PER CENT	FUSION TEMPERATURE WIRE METHOD	ULTIMATE TENSILE STRENGTH POUNDS PER SQUARE INCH	YIELD POINT POUNDS PER SQUARE INCH	ELONGATION 2 INCH GAGE LENGTH PER CENT	
Minimum	Degrees F. Minimum	Oven-Cooled Minimum	Oven-Cooled Minimum	Quenched Minimum	Oven-Cooled Minimum
75	1,750	150,000	125,000	15	4

The definition of quenched or softened alloy is: one which has been placed in a furnace at 1,290° F. for ten minutes and immediately quenched in water at room temperature, and for an oven-cooled or hardened alloy is:

one which, after quenching as above, has been placed in a furnace at 840° F. for two minutes and uniformly slow cooled to 480° F. in thirty minutes. The American method of short cutting all tedious operations has led to numerous modifications of the oven-cooling operation given above. Some of these give fairly satisfactory results. One of these consists of a salt bath made of equal parts of sodium nitrate and potassium nitrate. These salts can be melted in a metal container, and, if moisture and organic substances are kept away, there should be no danger of an explosion. This salt bath should have a special thermometer reading to at least 700° F. Many alloys, including inlay and clasp alloys, will show decided improvement if heated to 500° or 600° F. for a few minutes in this bath. The manufacturer's directions should be followed in all attempts at heat treatment.

TABLE II

REQUIREMENTS FOR DENTAL CEMENTS
(ABSTRACTED)

CONSISTENCY OF MIX	TIME OF SETTING AT 99° F.		ULTIMATE COMPRESSIVE STRENGTH		FILM THICKNESS	DISINTEGRATION
	MIN.	MAX.	MIN.	MIN.	MAX.	MAX.
	MINUTES	MINUTES	1 HOUR	7 DAYS		
			Kg./cm.² (lb./in.²)	Kg./cm.² (lb./in.²)	Microns	Per cent by weight
Disk 30 ± 1 mm. in diameter	4	10	350 (5,000)	840 (12,000)	50	1.0

HOW TO SECURE HIGH GRADE MATERIALS

After noting the details of these specifications the orthodontist may have a feeling of disappointment, as not every one is in a position to test purchases to be sure they are up to the high standard demanded by the specification. The orthodontist need not permit this feeling to disturb him, as the Research Commission of the American Dental Association has anticipated this situation[8] and has provided means for his protection. Harry E. Kelsey of this Society is a member of the special committee appointed by the Commission to cooperate with the National Bureau of Standards in an effort to secure the best dental materials possible for use by the government and the civilian dentists. The method by which this is achieved, without appreciable cost to the orthodontist, is by permitting manufacturers to certify and guarantee that their products are up to standard. This guarantee must be written on the container or accompany the sales transaction if requested. To assure the profession that the guaranteed quality will be maintained the Research Commission of the American Dental Association has representatives working in cooperation with the staff of the National Bureau of Standards. The materials which are guaranteed to meet the specifications of the Association are purchased from year to year on the open markets throughout the nation and are tested for quality. Materials not up to standard must be dropped from the list, and unless satisfactory explanation can be made the case is referred to the Federal Trade Commission for such action as seems proper. Those who read the *Journal of the American Dental Association* are familiar with

some of the instances in which this procedure has been followed. On new or improved products where you are not able to secure data promptly from Association reports you may always communicate with the manufacturer, asking whether the new product is guaranteed to be up to the standard set by the Association. Any attempt at evasion of the question should be grounds for suspicion. Any manufacturer having a high quality product must necessarily have testing equipment to use in maintaining factory control. With such equipment he can give you data to show how his product rates on the specification. Without such equipment he is taking extreme chances and cannot himself be sure of the quality of his product.

SUMMARY

1. Wrought gold alloys for the orthodontist are now available in uniformly high quality.

2. Marked improvement in physical or chemical properties of these alloys is not anticipated in the near future.

3. Decided improvements in the uniformity and service of most appliances can be secured by a proper heat treatment.

4. Structurally and mechanically the base metal alloys offered as substitutes for the gold alloys have not established their superiority and may carry a health hazard.

5. Zinc phosphate cements are at this date undergoing decided improvements in quality.

6. Adequate instructions for mixing these cements are being supplied.

7. After July 1, 1935, much of the chaos in the selection and manipulation of these cements will disappear.

8. By purchasing materials guaranteed to meet the specifications adopted by the American Dental Association the orthodontist will secure the best materials available.

9. By using these materials according to manufacturers' instructions the orthodontist will supply the best service to his patients.

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DISCUSSION

Dr. Harry E. Kelsey.—The Bureau of Standards Committee of the Research Commission of the American Dental Association is gratified by the second invitation to give a presentation before this Society by one of the research workers at the Bureau who are carrying on the investigation of dental materials there. It bespeaks an interest by the orthodontist

in the work which is being done there which is most encouraging to those who are responsible for carrying it out.

As a member of the Committee, I am naturally familiar with the work, but I shall not use much of your time in discussing it because I am sure there are many members here who would like to enter into the discussion, or ask Dr. Souder questions, his answers to which will be much more valuable than any comments I might make. I appreciate, however, the invitation to discuss Dr. Souder's paper because it gives me an opportunity to say something in regard to the objects and activities of the Research Commission at the Bureau of Standards. This, as you know, has been going on for about six years, and although during the earlier years of the Research some impatience might have been felt upon the part of members of the American Dental Association at what seemed to be an unnecessary delay in giving out data regarding the work, I believe it is now being generally appreciated that such data as are valuable and well digested are being given out as rapidly as is consistent with accuracy.

The policy of the government and the American Dental Association working together has been at all times to avoid rapid fire reports and frequent changes which could only work a hardship on the manufacturers and also on the members of the Association who are interested in the work. The manufacturers have shown their appreciation of this attitude by cooperating with the Bureau committee and the Bureau research workers in a most helpful and gratifying manner. They may have been fearful at the beginning that the object of the Bureau research was mainly to discover faults in materials and methods of manufacture, and devote a part of the time to a sharp criticism of them; but I believe they appreciate today, and have for some time past, that the only object is to aid in developing standards which are quite within the manufacturing possibilities of the well-equipped establishments and which will enable dentists and dental specialists to procure materials of such uniform character as to eliminate much of the uncertainty and disappointment which attends the use of unstandardized materials. It is not the desire nor will it ever be the policy of the Bureau to interfere in any way in the business of the manufacturer. There will be, of course, from time to time, rechecking of materials as purchased in the open market, but this will, of course, be as much to the interest of those manufacturers who desire to maintain high standards as it will to those who use the materials. There can be no doubt but that in the future, as in the past, dentists will have their favorite products, made by establishments in which they have confidence and, notwithstanding the fact that many firms will be making products that conform to established standards, will continue to have preferences based on excellent service in the past or the expectation of improved service in the future.

I should like to say a word here in connection with the history of the inception of the work on wrought gold alloys at the Bureau of Standards. Many members will recall that a request was made several years ago to the American Dental Association for funds to be allocated by the Research Commission for research in some branch of orthodontic science. This seemed a reasonable request since every member in the American Society of Orthodontists must be a member of the American Dental Association, and the Research Commission would gladly have devoted special funds to orthodontic research if such funds had been available, but as is well known, the resources of the American Dental Association were curtailed as were the resources of all other organizations and individuals since the depression, and it was not able to make a grant to the American Society of Orthodontists at that time. As a substitute for funds, however, part of the time of the Research associates and the Bureau representatives was allotted to research on orthodontic materials, especially wrought gold alloys, and later on, cement.

This research on orthodontic materials has been noted by other specialties, and there have been requests recently for work in their field, notably that of the prosthodontists who are, I think, somewhat bewildered by the number of new materials which are being offered as substitutes for vulcanite rubber in the construction of artificial dentures; and I may say that it is in the program at the Bureau to begin an investigation of such materials at an early date. In fact, it has already been inaugurated, though, of course, data

cannot be promised for some time, both because the other investigations which are under way must be carried to completion, and also because this is a rather new field in any event, and satisfactory data could not be expected in less than one or two years.

I shall ask your indulgence for only a few moments longer to make some comment upon the substance of Dr. Souder's paper. With his remarks regarding the wrought alloys, their use and treatment and the possibility of obtaining them from many different manufacturers I concur so fully that no further comment is needed. His comparison of stainless steel with the wrought gold alloys is interesting and covers the subject pretty thoroughly up to within the last six months or a year.

During this time, however, new methods of construction by more efficient welding apparatus with or without the use of solder as an adjunct has developed many enthusiasts, some of whom, at least, are using it now exclusively. Before this paper is read you will have had the opportunity at this meeting of listening to papers or of witnessing clinics which may give, and probably will give, the last word on stainless steel as a material for the construction of orthodontic appliances. Personally, I have used it for the last two or three years quite extensively but never exclusively, the ratio of wrought gold alloys to stainless steel in my practice having reached at no time a greater percentage than 70 or 75 per cent of gold to 25 per cent of stainless steel.

At first, I was by way of becoming an enthusiast myself, but the difficulty of making permanent attachments, together with the rather intractable nature of the material and my inability to retemper it in case its temper had been lost through the necessary application of heat, has cost so much in time and annoyance that unless new methods of welding eliminate the difficulties referred to, I shall return almost exclusively to the use of gold wrought alloys. I say "almost exclusively" because, at least for ligature wire, no metal has been found that is comparable to stainless steel. Its strength and toughness are such that considerable traction can be exerted by simply twisting the wire up with the pliers at intervals of one to three weeks. The same treatment with any other form of ligature wire that I have been able to find, means that it will twist off before it exerts much traction, on the first application of force, and is sure to break on the second.

Though in my experience the breakage of wrought gold appliances is somewhat greater than that of steel, other qualities far outweigh this difficulty, which is, by the way, far less pronounced since the great improvement that has been made in their manufacture. It is true that the comparative cost is quite striking but becomes much less when the salvage of gold alloys is taken into consideration. I think it must be said in regard to the galvanic action of stainless steel, that it is less pronounced than any of the other metals used in orthodontic construction, when used either by itself or in conjunction with other metals. At least, this seems to be the opinion generally expressed by those who have investigated the question. Personally, the value of stainless steel for appliances is a matter upon which I am still open to conviction.

Regarding the cement problem, I am still surprised at the remarkable variation shown in the various cements as a result of the investigation carried on at the Bureau. There can be no doubt that many manufacturers have long done their best to meet the requirements as detailed to them by members of the profession in whom they have had the most confidence, but standardization of such an article as cement can hardly be arrived at through experimentation in the mouth alone, though clinical use can be, and is most helpful in verifying the value of a product which has been standardized for certain qualities by exact scientific methods of research. For instance, after fifty years of use, dentists usually, and many manufacturers also believed that oxiphosphate cement had adhesive properties which were maintained after setting had taken place. We now know this to be fallacious. My attention was first called to it by Dr. W. H. Crawford, who is, I am glad to say, now a member of the Research Commission of the American Dental Association, in a paper which he read before the New York Society of Orthodontists three or four years ago. He had demonstrated the absence of this adhesive quality during some research which

he did on cements before it was taken up at the Bureau of Standards, and I hope Dr. Crawford will have something to say in the discussion of Dr. Souder's paper. Other qualities such as the proper fineness of the powder and the disintegration of the cement in the secretions of the oral cavity could not be and were not properly answered by clinical use or experimentation. There are many other interesting points brought out in the essayist's excellent presentation, but I will not take up more of your time.

In closing, I should like to say that both Dr. Souder and the Research Associates of the American Dental Association at the Bureau cordially welcome members of the profession to the Bureau, and I hope many members of this Society will be added to the increasing monthly list of those who visit there.

GROWTH OF THE JAWS AND THE ETIOLOGY OF MALOCCLUSION

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(Continued from page 933, October)

CHAPTER III

THE ANALYSIS OF LATERAL GROWTH

If we examine Table I, in which the increase and the decrease in the width of the dental arches of the same subject were recorded by Wallace, we shall observe that during growth and even after adulthood is reached the dental arches are subject to changes. The plastic nature of the supporting structures allows such changes to take place; so we must look upon the dental apparatus as being continually in a state of adjustment. At times, these changes become quite pronounced, and rapid widening of the arches takes place. During the transition from the deciduous to the permanent dentition the width is materially increased and usually reaches a value greater than that in the completed permanent denture.

This is apparent from the study of the measurements recorded in Table I. The intercanine measurement becomes 1.6 mm. wider at nine and one-quarter years of age than it will be at the age of twelve years. The distance between the second deciduous molars reaches its maximum value at nine and one-quarter years, and it is reduced by 1 mm. at twelve years. This table, however, does not represent the actual increase or decrease in the width of the arches which occurs in the transition from the deciduous to the permanent dentition. Unfortunately the models from which these measurements were taken were made from compound impressions, and for this reason the values recorded are subject to errors. Dragging of the impression material is clearly visible on the models. The increase or decrease in width between any two similarly located teeth as here given cannot be used to draw conclusions between the deciduous and the permanent sets of teeth. These measurements were taken between the middle points of the lingual gingival borders and the thicknesses of the teeth were not tabulated. It is evident that while Table I shows a decided decrease of intercanine distance in the permanent set, if the thicknesses of the teeth were taken into consideration, a very much smaller decrease would be noticeable, and it is possible that even an increase in the intercanine width would appear. The deciduous canine is a much smaller tooth than its permanent successor, and, even if there was no actual change in the intercanine width, the permanent canines must show a decided decrease on account of the greater thickness of these teeth buccolingually.

And again we may take the second deciduous molar which is replaced by the second premolar. In this case the second premolar width is much greater than

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the second deciduous molar width, because the permanent tooth is smaller in the buccolingual measurement than the deciduous tooth. It should be noted here that these differences could be eliminated by taking all measurements between the buccal cusps of the teeth. The arch form is determined by the buccal cusps of the posterior teeth and the incisal edges of the anterior teeth. Even in a mixed denture the buccal cusps and the incisal edges define the arch form, and the measurements made between the lingual gingival borders cannot be used in a comparison of the deciduous and permanent dentures. In order to understand the developmental changes, it becomes necessary to plot the values given in Table I, using "age" as abscissae and "interdental distances" as ordinates. Thus several curves would be obtained, one corresponding to each tooth, and the correlated study of these curves would reveal the important lateral changes during growth.

TABLE I

INCREASE AND DECREASE IN WIDTH OF THE DENTAL ARCHES

AGE OF CASTS	INTER-CANINE		INTER M_1 OR PM_1		INTER M_2 OR PM_2		INTER M_1		INTER M_2		INTER M_3	
YEARS	MAX.	MAND.	MAX.	MAND.	MAX.	MAND.	MAX.	MAND.	MAX.	MAND.	MAX.	MAND.
3.5	22.0	17.0	25.2	21.8	28.0	25.9						
6.0	22.4	17.1	25.4	21.8	28.5	25.9						
7.0	22.5	16.8	25.5	21.9	28.8	25.9	33.4	32.6				
7.5	22.9	17.4	25.8	21.9	29.0	25.9	33.0	32.7				
8.17	24.9	19.2	27.2	22.7	30.4	26.5	34.0	32.0*				
9.25	25.5	19.3	27.4	22.8	30.5	26.7	33.8	32.3				
11.0	24.7	19.5	27.4	22.4	29.8	25.9	33.5	31.2*				
12.0	23.9			22.0	29.5	25.5	34.0	31.2*				
12.25				21.7		25.4		31.4				
12.5						25.0		31.3				
14.5		17.2	27.3	24.2	31.8	27.8	33.9	31.1*	42.4	37.7		
17.0	23.7	18.1	27.8	24.5	32.0	28.5	34.5	31.4	41.5	38.5		
19.0	23.6	18.0	27.4	24.4	31.7	27.6	34.2	31.2	41.8	38.3	46.1	46.0
24.0	23.4	17.5	27.5	24.3	32.1	27.8	34.5	31.0	41.9	38.2	45.5	45.3

*Not corrected for drag.

Fig. 1 shows the character of these curves. The curves for the maxillary teeth are drawn in full, and those for the mandibular teeth in dashes. If we study these curves, we observe that the deciduous arches undergo a gradual widening during the first six or seven years of life. This widening of the arches takes place at about the same rate during the entire period; although the angle of inclination of the maxillary curves as compared with that of the mandibular curves indicates that the widening of the maxilla takes place more rapidly than that of the mandible.

With the eruption of the first permanent molars an acceleration of lateral growth occurs, and in about eighteen months to two years the maximum arch width during life is attained. This occurs at about nine years of age, and, before the posterior deciduous teeth are shed, a readjustment of arch form takes place. The establishment of maximum arch width is followed by a general narrowing of the arches, and all interdental distances are slowly diminished, with the exception of the distance between the two maxillary first permanent molars. At their time of eruption the maxillary and mandibular first permanent molars show about the same interdental distances, that for the

mandibular teeth being slightly shorter. Immediately following, however, the distance between the maxillary first molars gradually increases, while the distance between the mandibular teeth is diminished. It is important to note that these tendencies persist until the third molars erupt, when a slight diminution of all interdental distances occurs.

Another interesting condition observable from these curves is that the interdental distances in the same arch show a parallel increase or decrease. Before the first permanent molars erupt, all the maxillary curves are parallel. The mandibular curves indicate a similar condition, but the rate of growth is slower; and we find that, after the acceleration of growth takes place, the mandibular

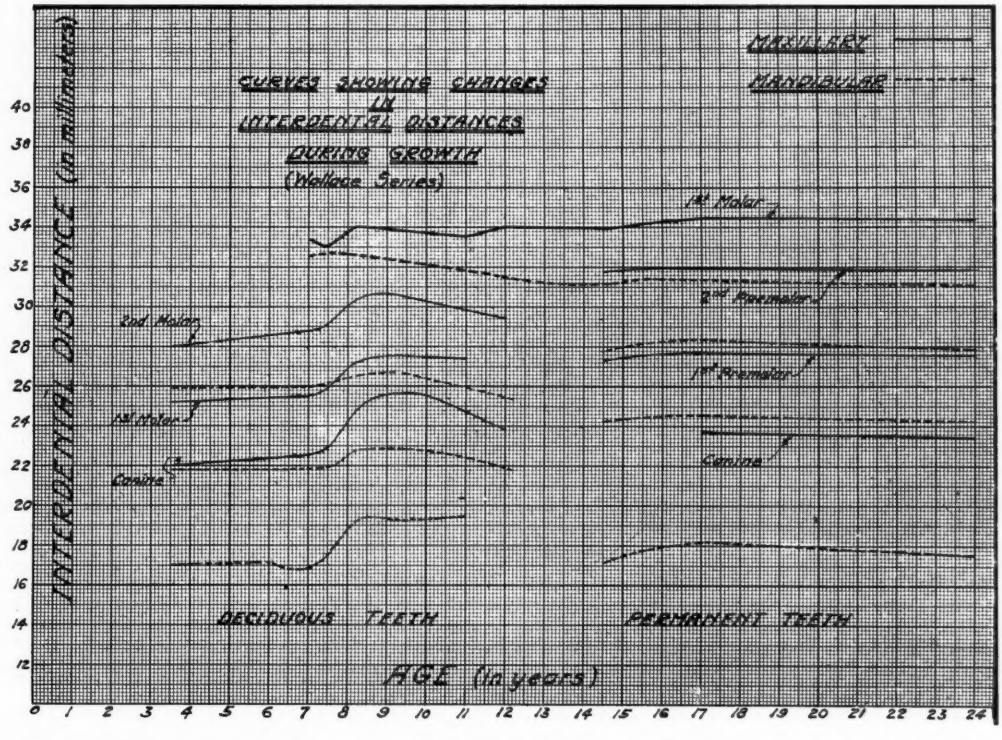

Fig. 1.—Curves showing changes in interdental distances during growth. (Wallace series.)

curves cross the maxillary curves. In the completed permanent dentition, on the other hand, the mandibular curves become parallel to the maxillary curves, which forces the conclusion that in a completed denture *maxillary and mandibular lateral changes occur simultaneously in equal amounts and in the same direction.*

The parallelism of the curves of the same arch is roughly recognizable even during the period of accelerated growth, and this establishes the condition that *the growth of a part takes place parallel to itself.* This is an extremely important condition, for it forms the basis of case analysis. It appears from the curves that this is only approximately true during the period of accelerated growth, but it must be remembered that our unit of measurement is the millimeter, which is an extremely small unit. Between seven and nine years of age the total increase in intercanine distance is 3 mm., which represents the

greatest increase occurring in this case. The distance between the second deciduous molars is increased only 1.7 mm. during that interval, which is the smallest increase observed. Thus there is a difference of a little more than a millimeter between these extreme values, and if we further remember that this difference is evenly divided between the right and the left halves of the arches, the buccal deviation from parallel growth in any position corresponding to the position of a particular tooth will not be more than a fraction of a millimeter. The curves show these developmental changes on a greatly magnified scale, and it is most remarkable that even under these exaggerated conditions the parallelism of lateral growth is recognizable. If these curves were plotted to actual scale, they would represent straight lines with a slight change of direction between seven and twelve years of age, and the smaller the scale the more apparent the parallelism would become. Therefore, the acceptance of the statement that the *growth of a part takes place parallel to itself* will not bring about appreciable errors.

While these changes are small, they are measurable, and they have a great influence on arch form. The widening and the narrowing of the arches are consistent with the increase and decrease of tooth material. There is a time during the period of transition when the tooth material present is greater than at any other time during the life of the individual. This usually occurs before the posterior deciduous teeth are shed, when there is the combination of the large permanent anterior and the large deciduous posterior teeth. In this combination the sum of the mesiodistal diameters of all the teeth in the arch exceeds that sum in the permanent or deciduous dentures; and whatever may be the law of arch formation, in the same individual a greater tooth material calls for a greater arch width. This is exactly what happens. From the models we know that the permanent lateral incisors erupted at about nine years of age. Curiously enough, the greatest width between all teeth occurs at this age, which marks the stage of greatest tooth material. Before the first deciduous molars are shed, a general narrowing of the arches occurs. This indicates that other processes are in operation besides the changing of tooth material. If we consider that the germ of the permanent tooth is always lingual to the corresponding deciduous tooth, and that after eruption the permanent teeth, as a rule, are found buccally to the deciduous teeth, then we must conclude that during eruption the permanent teeth have a buccal or labial tendency. They exert a definite lateral pressure in the posterior region and, as a result, cause a lateral displacement of the deciduous teeth by acting on their roots. Simultaneously the roots of the deciduous teeth are resorbed to a greater or lesser extent, and, when sufficient resorption takes place to allow the permanent teeth to move into a buccal position, the lateral pressure ceases to operate and the deciduous teeth drift back lingually. This is especially marked in the case of the deciduous canine which shows the greatest increase in interdental width. As soon as the tip of its root is resorbed, a further descent of the large permanent canine in a labial position forces the deciduous tooth lingually, and a marked diminution of the interdental width occurs. Thus the increase in arch width is due to the increase in tooth material and the lateral pressure exerted by the erupting permanent teeth;

while the decrease in arch width is due to the disappearance of lateral pressure on account of root resorption and in some instances the labial descent of a large permanent tooth. The comparatively rapid increase in arch width is only transitional, and the actual growth of the jaws and arches from the deciduous to the completed permanent dentition is gradual, and the final increase must be reckoned on this basis.

The crossing of the maxillary and mandibular curves gives a further confirmation to the observation that the mandible grows forward more rapidly than the maxilla. The greater rate of maxillary lateral growth demands that such excess of forward growth take place in the mandible, otherwise occlusion could not be maintained. As the maxilla widens, the difference in arch width is compensated for by the forward growth of the mandible, which brings a wider portion of the mandibular arch in occlusion with the rapidly expanding maxillary arch.

It is remarkable that such definite deductions can be drawn from a single series of models. Unfortunately, at present we do not possess another complete series from which these deductions can be verified, and in order to be more thorough a large number of similar series should be studied. The foregoing deductions, however, are supported in every respect by the valuable studies of James C. Brash on "The Growth of the Alveolar Bone," from which we gain additional information regarding the growth of the dental arches. From the work of Wallace we were able to establish the sequence of changes which take place in the dimensions of the dental arches during growth; from the study of Brash's work we shall understand those alterations within the bone itself which are responsible for the changes in arch dimensions.

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(To be continued)

A VISUAL PRESENTATION FOR THE PATIENT OF THE IMPORTANCE OF DENTAL SERVICES

H. B. Taylor, Toronto, Canada

AS A CANADIAN layman it gives me the greatest pleasure to have the honor of presenting to this distinguished body of men, representatives of a truly great profession, my contribution to the practice of dentistry and, more particularly, to the practice of orthodontia, which has rendered such an immeasurably great service to my own son.

Over a year ago, in my capacity as a life underwriter, I had the privilege of presenting to Dr. Vernon Fisk a proposal for a deferred annuity through the medium of a chart embodying a technic quite new for this purpose.

To Dr. Fisk belongs the credit for suggesting the use of my technic in orthodontic practice. This suggestion was acted upon immediately, and with his whole-hearted cooperation, extending over a period of a year, the malocclusion chart was brought to its present state of development. During this time the chart was revised many times, each revision prompted by constructive criticism or research and resulting in further definite improvement.

During the compiling of this chart it was recognized to be of the utmost importance to incorporate in it the systemic effects of the neglect of misplaced teeth. It was, therefore, necessary that I have the cooperation of men of high standing in the medical profession, and, wherever such cooperation was sought, it was most generously given, particularly by the chairman of the Periodic Health Examination Committee of the Ontario Medical Association. He, in turn, was so impressed with my work that he asked if I would undertake with him and his committee the compiling of a chart setting forth the benefits of periodic health examination. This chart was completed, and an enlargement of it was displayed as a scientific exhibit at the last combined convention of the Canadian and Ontario Medical Associations. Just recently I had the privilege of compiling in collaboration with this same committee a second and much more comprehensive chart on periodic health examination, which is now being distributed by this committee to the members of the medical profession throughout Canada.

Just as soon as I began to distribute the Malocclusion Chart (Chart 1) and the first Periodic Health Examination Chart, I met with a unanimous request from the general dental practitioners for a chart that would be just as useful to them in general practice as the Malocclusion Chart would be in demonstrating the possible effects of misplaced teeth. In compliance with that request I compiled the second chart which I shall show here.

Presented at the Thirty-Third Annual Meeting of the American Society of Orthodontists, New York, N. Y., April 30, May 1, 2, and 3, 1935.

Throughout the development of this chart I had the invaluable cooperation of Dr. J. A. Bothwell of Toronto and also again that of Dr. Fisk. Helpful assistance was also given by other members of the dental profession as well as by some of our leading medical authorities, whose valuable suggestions greatly enhanced the effectiveness of the charts.

All through this undertaking I have had not only the heartiest cooperation of these men but also the inspiration, encouragement, and unanimous approval of men of the highest standing in both the medical and the dental professions. This has thoroughly convinced me that there is no end to what can be accomplished for the benefit of the public through the dissemination of knowledge on health subjects by means of the technic which it is my pleasure to present here.

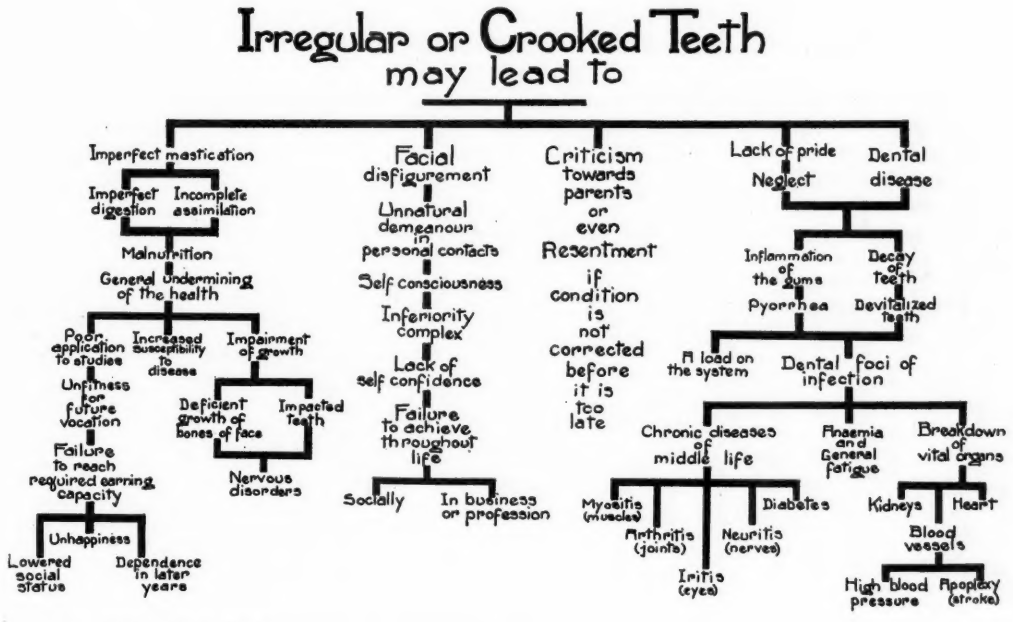

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Chart 1.

Since I have given a brief account of the development of the charts, let us consider why it is important that the information contained in them should be brought to the attention of the general public.

In the first place, parents frequently fail to realize fully the importance of the correction of misplaced teeth or to what extent such a condition, if neglected, may retard or even wreck the development of a child's two most valuable assets—his character, or personality, and his health.

With the Periodic Dental Examination Chart particularly in mind, may I refer to what Dr. Rosenow has said: "It seems to me that a public health propaganda should be inaugurated to inform people of the dangers to their health that may arise from infected teeth and how these dangers may be avoided. Prophylaxis should be the watchword." Chart 2 is presented as the answer to that problem.

You and I, as parents, have four main interests in life. These four interests have been kept constantly in mind during compiling of the charts.

1. The welfare of our children throughout life.
2. The keeping of their love and respect not just now, not just for as long as we live, but for as long as they themselves shall live.
3. Our own economic and social status throughout life.
4. The preservation of our health.

It happens at times and all too frequently that, in the struggle to maintain our own economic and social status, we may—through lack of knowledge or neglect—fail to correct the very condition which may be the cause of our

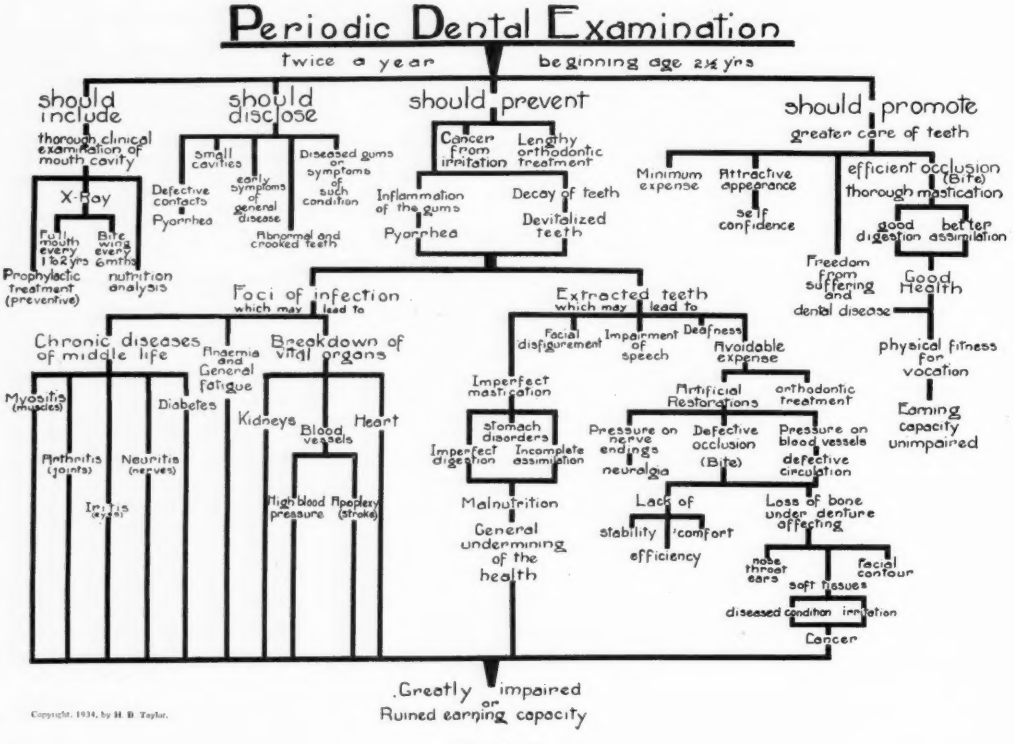

Chart 2.

economic downfall through loss of health and consequent loss of earning power; or for the same reason, that is through lack of knowledge or neglect, the welfare of our children may be overlooked.

It is my sincere belief, based upon the opinion of those to whom I have already referred as well as my own past experience with the charts, that they will, if properly used, be of inestimable value in the promotion of these four fundamentally important interests.

Chart 1 has been found very helpful in presenting visually to parents the results of the neglect of misplaced teeth and the detrimental effects of such a condition upon their children from a mental, moral, physical, social or economic standpoint.

How such neglect may result in straining very severely the love and respect of their children is also clearly set forth.

I think it was Dr. Oliver T. Osborne of Yale who said, "Dentistry has now been exalted to the highest rank in preventive medicine."

It seems to me that what is needed most is some effective means of bringing about the general acceptance of this truth and of presenting to the patient and the prospective patient the importance of dental services generally and, more particularly, the importance of the correction of misplaced teeth, to the end that a vast amount of physical and mental suffering and disease may be prevented, that countless thousands of human beings may not suffer reduced or ruined earning capacity but may live longer and enjoy life more fully.

Most people are eye-minded. Therefore, I respectfully submit that this chart technic, which makes possible the visual presentation of ideas, constitutes, if consistently employed, a highly effective means of accomplishing this objective.

TISSUE CHANGES INCIDENT TO TOOTH MOVEMENT*

A. F. Heimlich, D.D.S., Santa Barbara, Calif.

THE orthodontist is primarily concerned with the movement of the teeth. If we can get the true picture of the tissue changes incident to tooth movement and retention; if we can visualize the histologic transformations of the delicate structures with which we work, we will have gone far toward our common goal: a unity of purpose and ideals and an agreement on fundamental principles of treatment.

In this connection I feel that it would be well to review some recent scientific contributions. Albin Oppenheim[1] of Vienna has recently published in the International Journal of Orthodontia and Children's Dentistry a series of articles entitled "The Crisis in Orthodontia." All of us are deeply indebted to Oppenheim for the favorable effect he has had on orthodontia since 1911, practically furnishing us with our biologic background since that time and causing the pendulum to swing back from strong to gentle forces

The following observation was made by Oppenheim in 1911, based on the transformation theory of Wolff and the experimental work of Sandstedt in 1905 and 1906. "The bone tissue, compact as well as trabecular bone, reacts upon pressure with the transformation of its entire architecture. This takes place through resorption of the present bone and apposition of new bone. Both processes start simultaneously."

Oppenheim's experiments were performed on monkeys because of their similarity to man in gross and microscopic anatomical features. That these experiments have been made on deciduous teeth in no wise detracts from their value, since the work was done on fully formed teeth. Furthermore, tissue changes around deciduous teeth due to external pressure and those caused by the natural shedding process have been shown to differ greatly.

The objection that Oppenheim's work was done on monkeys and is, therefore, not applicable to man is at least partially answered by the work of Herzberg,[2] who recently made and studied histologic slides taken from a specimen of a human premolar which had been moved orthodontically for seventy days. A piece of the buccal plate had been removed with the premolar. Microscopic examination showed findings almost identical with those of Oppenheim. Since the experiments were made under the same conditions as those of Oppenheim, this constituted a practical justification of his work.

The experiments from which Oppenheim draws his conclusions were made as follows: Central incisors were ligated to an expansion arch anchored to the molars, and force was applied at intervals of five days over a period of forty days. In other words, seven adjustments were made. Simple forms of tooth movement were accomplished, mostly tipping, but some elongation and intrusion. After forty days the animals were killed and the teeth and jaws studied microscopically from sections.

*Presented to the American Board of Orthodontia.

It was found that the solid wall of the alveolus was broken up, both on the side of pressure and on the side of pull, into small trabeculae. These were arranged parallel to the lines of force. On the side of pressure the ends of the spicules in apposition to the tooth showed the presence of osteoclasts; the other end showed the presence of osteoblasts. On the side of pull the reverse was true.

This is very instructive in our clinical work. For example, it demonstrates how the very thin labial and buccal plates of bone are constantly being transformed during the labial and buccal movement of teeth and thus, in effect, seem to move away from the tooth by new formation of bone. This picture presupposes physiologic movement.

The use of gentle intermittent force enabled the periodontal membrane to recover during the rest periods and to regain its ability to act in a biologic manner, reestablishing its blood supply, forming osteoclasts to resorb bone, and also permitting the cementum to regain its blood supply and resistance to resorption.

In experiments with very strong forces operating over a period of thirty days, Oppenheim made the following observation. Given a condition of excessive force applied to a tooth, we find the periodontal tissue crushed between the tooth and the wall of the alveolus on the side of pressure. Here we find an acute pathologic condition: hemorrhages, disturbance of circulation, tearing of fibers, etc. The periodontal membrane can no longer produce osteoclasts to resorb bone, nor can the cementum maintain its blood supply and remain impervious to resorption. When this condition exists, it takes a long time for the tooth to recover and for tooth movement to progress normally. In such a condition we can readily see that rapid movement will not lead to rapid progress, rather the reverse. If resistance is met, treatment should be prolonged rather than forced.

The picture in the case of gentle continuous force, operating over a long period, is claimed to be similar to that found in severely strong forces. Oppenheim[3] says, "Here the danger lies in the small limits of permissible pressure. Because it acts continuously, this type of pressure leads to a compression and anemia of long duration. This reduces the vitality of the periodontal membrane and creates a situation that is responsible, on the one hand, for lack of proper bone reactions and, on the other hand, for the development of root resorptions." Oppenheim gives no histologic verification of this statement, which seems strange in view of the fact that he greatly stresses this point.

Concerning the amount of permissible force in tooth movement, Schwarz,[4] working on the premolars of dogs with auxiliary springs of known force, concluded that biologic force in orthodontia could only be such force as would not exceed the capillary blood pressure of the periodontal membrane. Schwarz determined this force to be between 20 to 26 grams per square centimeter of root structure under pressure. Any pressure above that he found to be unbiologic. Hellman[5] says, "Physiologic treatment can under no circumstances be construed to mean any sort of mechanical procedure, regardless of

what type of orthodontic appliance is used or how well it is manipulated or controlled," thus implying that biologic changes due to orthodontic treatment can be only relative. It would seem that for the present we must be guided by our clinical experience and our knowledge of bone transformation in determining the amount of pressure to use.

Oppenheim's experiments showed that during intermittent treatment there is an overproduction of osteoid tissue in the bone trabeculae which tends to make the peridental space thinner. It is claimed by some authorities, among them Gottlieb, Orban and Schwarz,[6] that this osteoid tissue is dangerous and leads to root resorption. Oppenheim claims that despite the fact that this osteoid tissue is denser than ordinary bone, the renewed movement of the teeth does not injure the cementum. The teeth are held more firmly and tend to be less sensitive because of the presence of this heavily calcified bone.

With regard to root resorption, Oppenheim quotes Sandstedt[7] to the effect that "only if treatment is carried on irrationally, if the forces are too strong, too sudden, or unfit for tooth movement; only then will the tooth be damaged." Considering the length of time since Sandstedt made the above statement, it is quite remarkable. Though cementum and bone are very closely related in origin and structure, given conditions conducive to normal biologic changes, the cementum is less liable to resorption than the newly formed osteoid bone, or the normally calcified old bone. This must be true, for on this premise the entire program of orthodontic therapy is based.

Oppenheim says an occasional slight root resorption should not be considered too seriously. Usually there is a replacement with secondary cementum, having an equivalent anchorage for periodontal fibers.

In addition to the proper amount of force correctly applied, biologic tooth movement is dependent on rest periods and functional stimulation. The very fact that growth and development as well as all the natural forces acting on the teeth and surrounding tissues are intermittent bears this out.

Oppenheim's findings on retention were also performed on monkeys. They illustrate bone transformation during the period of retention. These experiments include a period of rigid fixation for three months in some cases and six months in others. He also made experiments under full functional stimulation for three- and six-month periods.

Teeth were moved prior to retention with the Angle wire and ligatures, gentle intermittent forces being used. The most significant of his findings were as follows: The transformation of bone during active orthodontic treatment as well as during the period of retention is performed exclusively by bone cells. Transformation in the case of rigidly retained teeth during retention is not so rapid as in those teeth which are permitted full functional stimulation. As I see the picture of retention, after orthodontic movement is discontinued and the tooth retained in its new position, retention must allow the spicules of bone which under the influence of orthodontic force have become arranged at right angles to the vertical surface, to become rearranged more parallel to the vertical surface of the tooth, thus corresponding best to the forces created by normal function. The bone thus reassumes its original

structure and finally a solid bone plate again surrounds the tooth. The periodontal fibers must also adapt themselves to the new direction of stimulating force.

Oppenheim found that in the teeth of monkeys full functional stimulation for six months is not sufficient to bring back the original normal condition. Since the span of a monkey's life differs so greatly from that of man, definite conclusions with regard to time of retention cannot be made from the above experiments. Oppenheim, however, cites Marshall[8] to the effect that any particular period in the life of a monkey multiplied by five would correspond to the same period in the life of man. The result transcribed in terms of Oppenheim's experiments on retention would lengthen the retention period of six months on the monkey to thirty months, or two and a half years on man; and even that length of retention, adapting this hypothesis, would be insufficient to bring conditions back to normal, even granting functional stimulation. On the basis of these experiments, we would do well to make sure that our cases are stabilized before dismissing them.

CONCLUSION

The chief importance of Oppenheim's contribution to date is the very clear histologic picture given of the response of bone, peridental membrane and cementum to orthodontic therapy. Because no force, however slight, used in orthodontic treatment can simulate the natural forces of growth and development, very gentle forces must be used in treatment. If continuous gentle forces are used, then the rest periods must be longer and the amount of pressure less than in the case of intermittent treatment. Rest periods and functional stimulation are essential in all cases. Osteoid tissue formed incidental to intermittent treatment is not detrimental to the cementum. Occasional slight resorptions need not cause undue alarm. When resorptions occur, however, it is well to ascertain that no adverse metabolic disturbances are present.

As yet, there can be no definite amount of force applicable to every case. Firmness and lack of pain in the teeth, together with our knowledge of physiologic changes, are our only clinical guides as to the amount of pressure which may be applied in a given case.

The type of force used is not important, rather its application. The appliance must be absolutely stabilized and under the control of the operator. Treatment must be planned so that the teeth can move uniformly to their correct positions, thus avoiding the repeated transformation of bone which is the result of permitting teeth to move back and forth and roundabout. Force control, therefore, is essential. If it is necessary to band a number of teeth to secure force control, this should be done. If the result may be accomplished in simpler ways, simpler appliances should be used.

Until the time when orthodontic appliances become more universally standardized, let each man use the appliances which in his hands are the most efficient; but let us all be in agreement on fundamental principles of treatment.

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SOME NOTES ON NORMAL OCCLUSION*

HAROLD CHAPMAN, L.D.S., LONDON, ENGLAND

EXAMPLES of normal occlusion, in the case of two sisters, are shown in Figs. 1 and 2; the legends are written as part of the text; it is not intended to point out all the changes enumerated by Friel.[5]

FIG. 1.—NORMAL OCCLUSION. (No treatment.)

The occlusal relations of all the teeth of one side and the changes in those relations cannot be shown in two photographs; hence separate series of photographs are necessary to show canine relations (Fig. 1 *c, f, k,* and Fig. 2 *e, f*) and molar relations (Fig. 1 *d, g, m,* and Fig. 2 *c, d*).†

The vertical lines on the teeth are drawn through the same point (from the triangular ridge of the mediobuccal cusp of $\underline{E \mid E}$ and in the buccal groove of $\overline{E \mid E}$) in each case to enable the reader to see at a glance the change in the mediodistal relations of the teeth: the marked surfaces are neither vertical nor parallel to one another; this also leads to difficulty in reproduction, but every care has been taken to show as accurately as possible what may be seen on the models.

(*a*) Age 5-7.‡ Occlusal view. Spaces between all maxillary deciduous incisors, also behind maxillary and mandibular canines. Very little or no attrition. $\frac{6 \mid 6}{6\ 1 \mid 1\ 6}$ erupting. Breadth§ $\underline{C \mid C}$ (cusp points), 30 mm.

FIG. 2.—NORMAL OCCLUSION. (No treatment.)

(*a*) Age 3-10. Occlusal view. Spaces behind all the canines and between all the maxillary and mandibular teeth in front of these except between the central incisors. Very slight incisor spacing (*cf.* Fig. 6). $\overline{C \mid C}$ widen 0.75 mm. in next 2-2 years.

(*c*) Age 3-10. Right side to show $\frac{\underline{E} \mid}{\overline{E} \mid}$ occlusion. $\overline{E} \mid$ buccal groove coincides with cusp point of mediobuccal cusp point of $\underline{E} \mid$.

(*d*) Age 6-0. Right side to show $\frac{\underline{E} \mid}{\overline{E} \mid}$ occlusion. $\overline{E} \mid$ buccal groove slightly more in front of the cusp point of mediobuccal cusp point of $\underline{E} \mid$ than at age 3-10. The overbite is less than at age 3-10.

(*b*) Age 5-7. Right side to show $\frac{\underline{E} \mid}{\overline{E} \mid}$ occlusion. $\overline{E} \mid$ buccal groove distal to cusp point and triangular ridge of mediobuccal cusp $\underline{E} \mid$ (*cf.* Fig. 1 *d*). This

*Transactions of British Society for the Study of Orthodontics, 1934.

†Suggestion of Dr. Sheldon Friel.

‡Age 5-7 means 5 years 7 months.

§As in the report, the term breadth is here used to denote the span across the arch; the term width is used to indicate the extent of a tooth from side to side, whether buccolingually or mediodistally.

difference on the two sides persists until age 9-5, but $\frac{6\ C|}{6\ 3|}$ appear to be in normal mediodistal relations. No models later than age 9-5 available.

(*e*) Age 6-9. Occlusal view. Spaces behind all deciduous canines closed. $\frac{1|1}{2|2}$ erupted. $\underline{1|1}$ spaced 3 mm. No noticeable increase of attrition. Breadth $\underline{C|C}$ (cusp points), 33 mm.

Fig. 1.

(*h*) Age 9-5. Occlusal view. $\overline{3|3}$ have erupted; $\overline{4|4}$ are erupting; spaces between maxillary incisors, but that between $\underline{1|1}$ is now only 1 mm.; spaces between $\underline{C\ 2|}$ and $\underline{|2\ C}$ (*cf.* Fig. 4); all these spaces will be closed when the permanent canines are in position. No noticeable increase of attrition. Breadth $\underline{C|C}$ (cusp points), 35 mm.

(*c*) Age 5-7. Left side to show $\frac{|C}{|C}$ occlusion. The tips or cusp points of $\overline{C|C}$ do not occlude between $\underline{C\,B|}$ and $\underline{|\,B\,C}$ at this period, but more distally; overbite considerable.

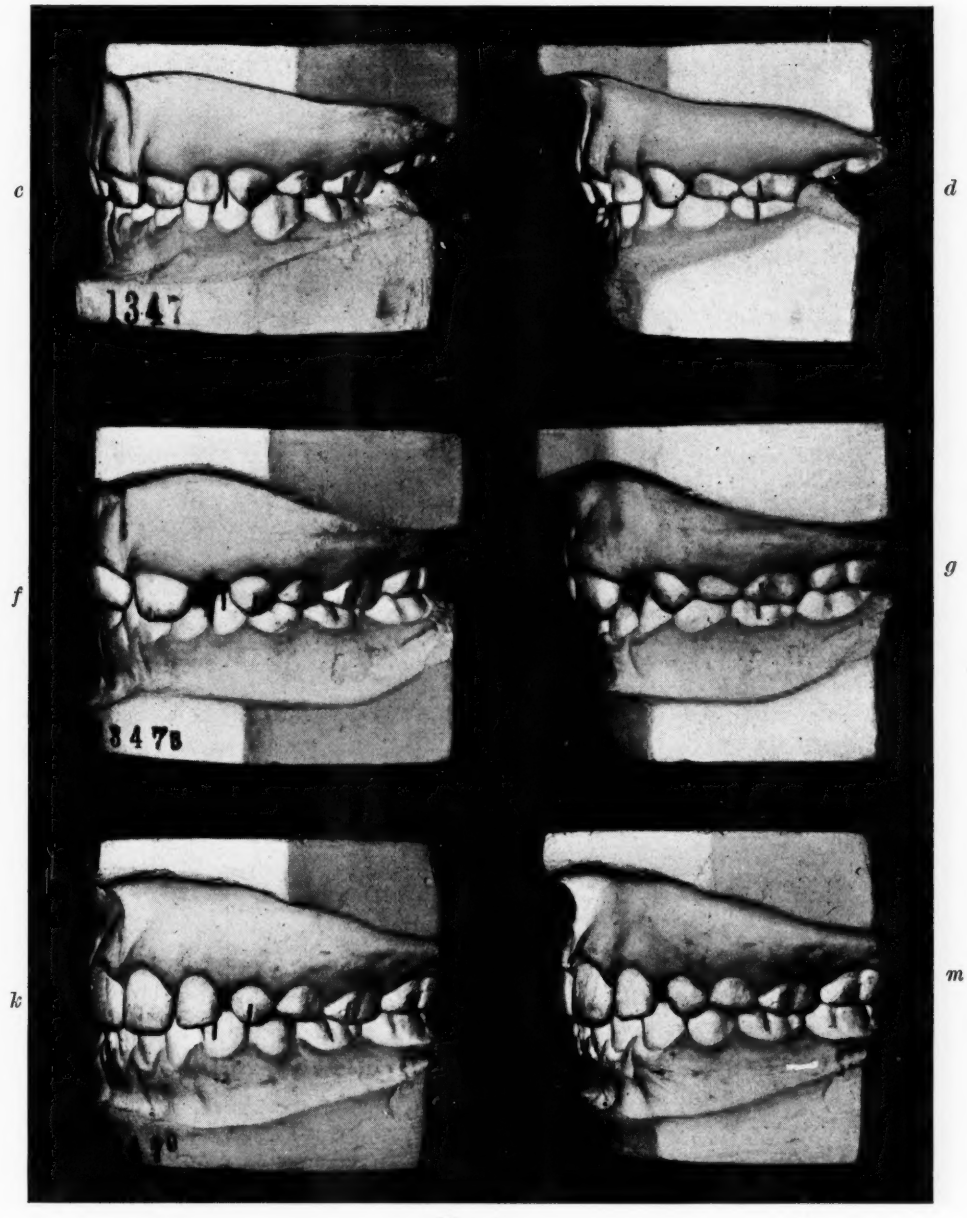

Fig. 1.

(*f*) Age 6-9. Left side to show $\frac{|C}{|C}$ occlusion. $\overline{|C}$ more medial in relation to $\underline{|C}$ than in Fig. 1 *c;* overbite as in Fig. 1 *c*.

(*k*) Age 9-5. Left side to show $\frac{|C}{|C}$ occlusion. $\overline{|3}$ cusp point between

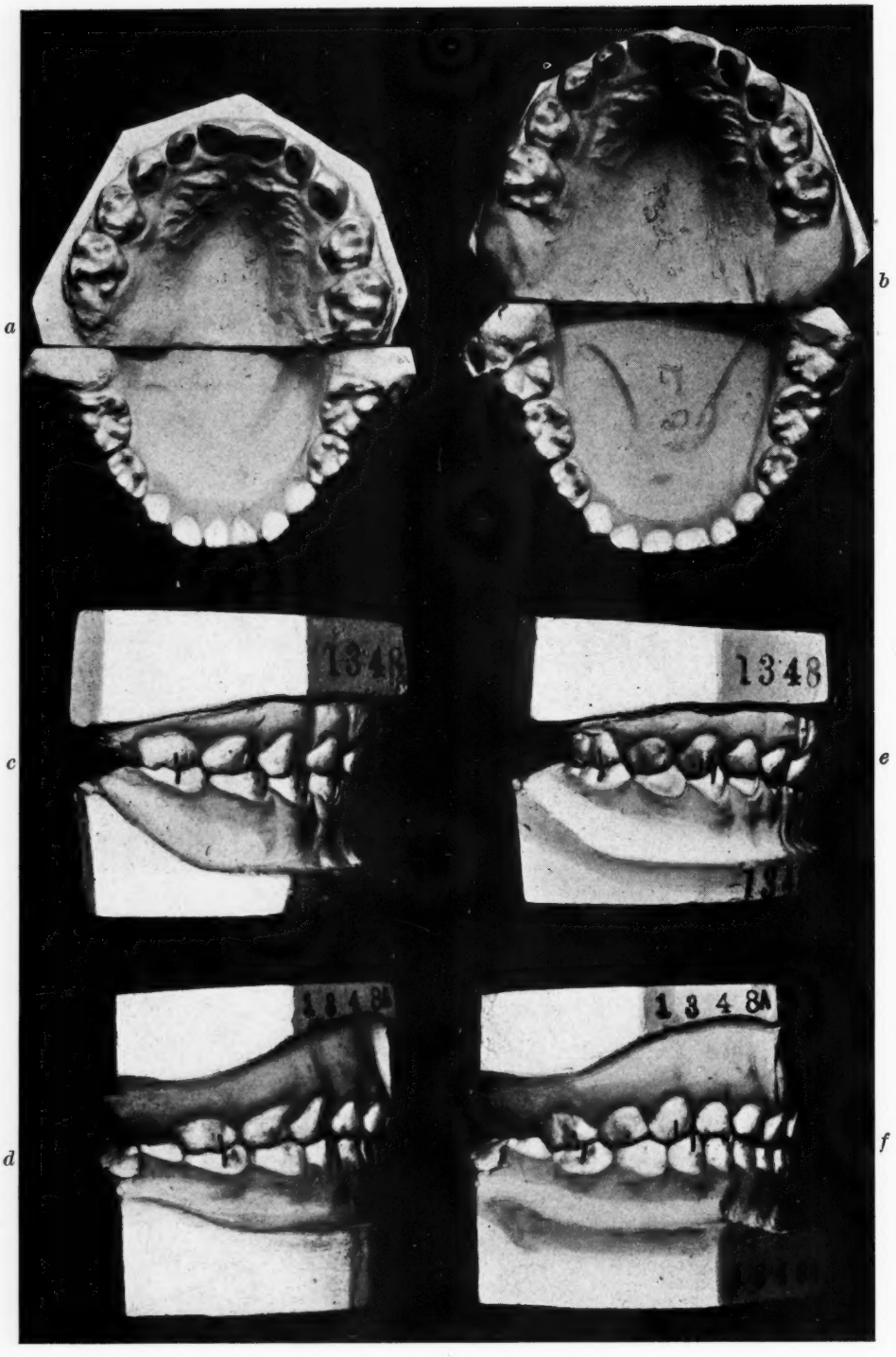

Fig. 2.

| 2 C. Overbite as in Fig. 1 *f*. Considerable space between | 2 C (*cf.* Fig. 4, age 9-2, no space).

(*d*) Age 5-7. Left side to show $\frac{|\,E}{|\,E}$ occlusion. $\overline{|\,E}$ buccal groove fractionally medial to cusp point and triangular ridge of mediobuccal cusp |E (*cf.* Fig. 1 *b*).

(*g*) Age 6-9. Left side to show $\frac{|\,E}{|\,E}$ occlusion. $\overline{|\,E}$ more medial in relation to | E than in Fig. 1 *d*. More contact between $\overline{|\,E}$ and | D when in occlusion than at age 5-7. Normal relation of $\frac{|\,6}{|\,6}$ at this age.

(*m*) Age 9-5. Left side to show $\frac{|\,E}{|\,E}$ occlusion. $\overline{|\,E}$ markedly more medial in relation to | E than at age 6-9; $\overline{|\,6}$ is also more medial in relation to | 6. Overbite normal.

There has not been the marked change in the overbite that is to be observed in Fig. 2.

TABLE TO SHOW WIDTH OF ARCH (IN MILLIMETERS)

AGE	BUCCAL SURFACE C | C	D | D[1]	E | E[2]	6 | 6[3]
5-7	34.20	34.00	39.10	43.10[4]
6-9	37.00	35.20	41.10	45.75[5]
9-5	38.20	37.20	42.60	47.00
Increase in 3-10 years	4.00	3.20	3.50	4.10
Corrected figure				2.50

[1] D | D measurement taken from the medial groove at the convergence of the mediobuccal and mediolingual cusps.

[2] E | E measurement taken from the medial groove at the convergence of the mediobuccal and mediolingual cusps.

[3] 6 | 6 measurement taken from the central fossae at the base of the lingual cusps.

[4] $\frac{6\,|}{6\,|}$ and $\frac{|\,6}{|\,6}$ are not in occlusion.

[5] $\frac{6\,|}{6\,|}$ are not in occlusion; 6 | has to go lingually or $\overline{6\,|}$ buccally, or both movements have to occur before $\frac{6\,|}{6\,|}$ will occlude correctly; not more than 1.60 mm. lingual movement of 6 | will bring their relationships correct, hence the "corrected figure."

Summary of points to be noticed in Fig. 1.

Spacing behind $\frac{C\,|\,C}{C\,|\,C}$ at age 5-7, which does not exist at age 6-9, probably closed by C | C going distally (and if distally also buccally): this might cause an increased C | C breadth of 1 mm. Space between | 2 and | C at age 9-5.

During 3-10 years C | C have widened 4 mm. and 6 | 6 2.50 mm.

No noticeable attrition; no change in overbite.

Difference in the mediodistal relation of $\overline{E\,|}$ and $\overline{|\,E}$ to the maxillary teeth at age 5-7, which persists until age 9-5, when $\frac{6\,C\,|\,C\,6}{6\,3\,|\,3\,6}$ appear to be in normal occlusion. Center lines coincide in all three sets of models.

(*b*) Age 6-0. Occlusal view. All canine spaces have disappeared except maxillary medial, but all other spaces as before except $\overline{1 \mid 1}$ are erupting and there are no spaces on either side of them. Some attrition of $\frac{C \mid C}{C \mid C}$.

(*e*) Age 3-10. Right side to show $\frac{C \mid}{C \mid}$ occlusion. $\overline{C \mid C}$ cusp points are distal to the spaces between $\underline{C\,B \mid B\,C}$, especially the left one. Overbite considerable.

(*f*) Age 6-0. Right side to show $\frac{C \mid}{C \mid}$ occlusion. $\overline{C \mid}$ is considerably more forward than at the earlier period, the cusp point being between $\underline{C\,B \mid}$ now and its medial incline in contact with $\underline{B \mid}$. Reduction of overbite in 2-2 years.

TABLE TO SHOW INCREASED BREADTH OF ARCH (IN MILLIMETERS) BETWEEN AGES 3-10 AND 6-0

	$\underline{C \mid C}$	$\underline{D \mid D}$	$\underline{E \mid E}$	$\underline{C \mid C}$
Increase in 2-2 years	0.50	0.50	1.00	0.75*

*If the bite opens it becomes possible for $\overline{C \mid C}$ to show greater breadth increase than $\underline{C \mid C}$.

Summary of points to be noticed in Fig. 2.

During two years (age 3-10 to age 6-0) spaces on both sides of $\frac{C \mid C}{C \mid C}$ have all disappeared at age 6-0 (except $\underline{C \mid C}$ medial).

Medial movement of all the mandibular teeth in relation to the maxillary ones.

Considerable opening of the bite. Some attrition.

Another case, previously described,[2, 3] is shown in Fig. 3, ages 4-0 and 9-2; Fig. 4, age 9-2, and Fig. 5, age 20-1; in Fig. 3, notice the change of overbite; in Figs. 4 and 5 the width across $\underline{C \mid C}$ and $\underline{3 \mid 3}$, mediolingual surfaces, is exactly the same; this surface of the canines, deciduous and permanent, may perhaps be considered as a fixed point (as far as this term is permissible). Between the ages of 9-2 and 20-1 there has been an increase in the width of the maxillary first permanent molars of 1.15 mm., and of the mandibular ones of 0.3 mm. Fig. 6 is the occlusal view of this case at 4 years of age.

The cases presented above are a study of individual examples of normal occlusion. Normal occlusion has also been studied *en masse* by the statistical method; the results are presented in "Facial Growth in Children,"* [8] by Miss K. C. Smyth and Dr. Matthew Young, a publication of the Medical Research Council, Special Report Series, No. 171. This report has received little notice in comparison with the enormous amount of work required for its compilation. Some details of the report are now discussed.

It is significant that the general characters of developing normal occlusion, as seen in individual cases, are brought out by the statistical method; however, the practitioner should not neglect to collect and study series of models of cases as these show the changes as they occur and bring out details which probably cannot be observed in other ways.

*The page references in the text are to pages in "Facial Growth in Children."

The report deals solely with normal occlusion and facial growth in cases of normal occlusion; it is based on the results of the examination of 1,200 children who had a morphologically normal or ideal type of occlusion and were 6 per cent of those examined, but an additional 2 per cent (estimated) with the

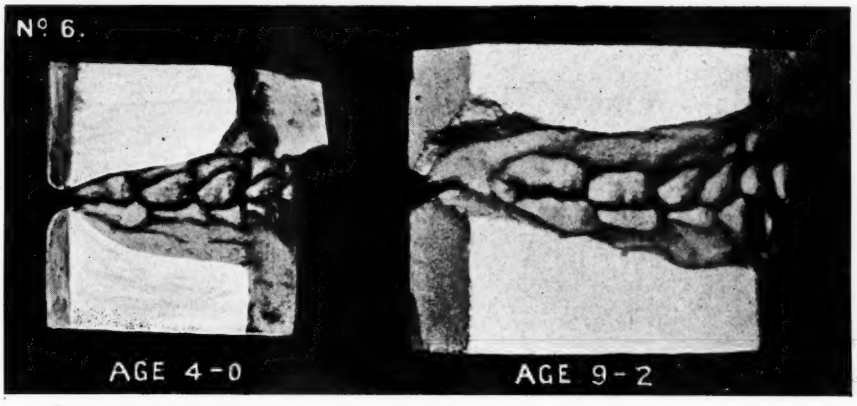

Fig. 3.

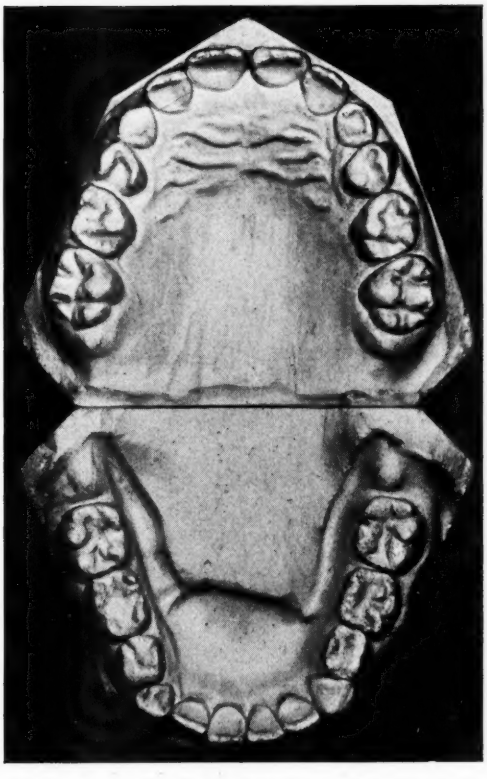

Fig. 4.

same type of occlusion were rejected; this makes a total of 8 per cent with ideal occlusion (a much higher standard of occlusion than normal), and strikes a casual observer as being higher than would be expected. There are numerous facial measurements in addition to the dental measurements.

The measurements of other workers are confirmed as regards increase in breadth of the deciduous arches during the persistence of the deciduous molars.

New measurements, which are further evidence of growth, e.g., the increased breadth $\frac{6|6}{6|6}$, ages 8-14 years (Table II, page 27, Facial Growth in Children), are included:*

		INCREASE OF BREADTH OF ARCH	
		MAXILLA $\underline{6|6}$	MANDIBLE $\overline{6|6}$
Ages 8-14	Boys	1.13†	0.84†
	Girls	2.38	1.57

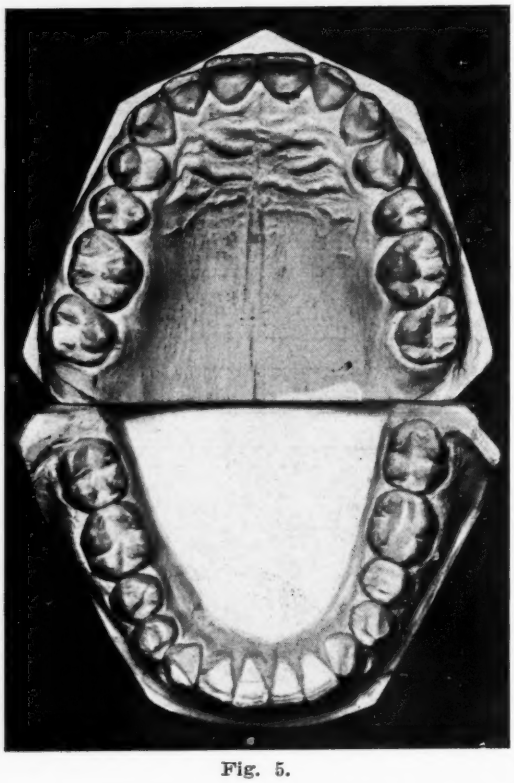

Fig. 5.

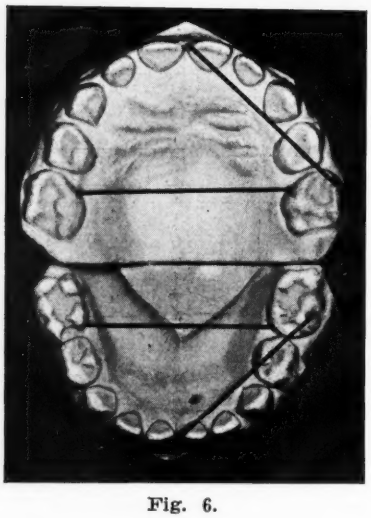

Fig. 6.

POINTS OF MEASUREMENT

The procedure adopted for dental measurements calls for comment.

At the beginning of the investigation *internal* measurements of the breadth of the maxillary and mandibular dental arches at $\frac{D|}{D|}$ or $\frac{4|}{4|}$ and $\frac{6|}{6|}$ were taken, but later these measurements were abandoned and "maximum" external measurements at the same teeth were taken in their place; no reason for the

*The only other $\frac{6|6}{6|6}$ breadth measurements in the same individual, having normal occlusion, at different ages, which the writer has found in the literature, are by:

Spiller[9] (one case), Sim Wallace[11] (one case), Zsigmondy[12] (one case).

†It is stated on page 45 of the report that "The number of observations is relatively small . . . and probably inadequate"; see table under heading "Buccal Breadth of Dental Arches at $\underline{6|6}$ and $\overline{6|6}$," in which the result of the measurements are more as would be expected.

change is given. If the internal measurements had been used throughout the increase in width, which the external measurements show to have occurred, would have been less, or even shown not to have occurred.

Buccal (maximum external breadth) and lingual measurements—made for purposes of comparison—could only be satisfactory if taken at the same point, obviously very difficult on surfaces possessing contours, such as the teeth concerned, a task not rendered easier by having to be made in the mouths of children (pages 10 and 16, Facial Growth in Children). To compare measurements made from deciduous teeth and those made from their permanent successors, as if they were the same object, does not carry conviction.

Buccal Measurements.—Maximum external breadth of dental arch (B* at $\underline{D|D}$, at $\overline{6|6}$, etc.) is taken to mean that the measurements (in view of the ages at which they were taken) were made at the gingival margin; it does not seem possible they could have been "taken at the neck of the tooth at the base of the distobuccal cusp" (page 16, Facial Growth in Children).

Whether the arch breadth is measured at the base of the mediobuccal or distobuccal cusp (gingival margin) of $\underline{D|D}$, there is an increase in breadth, as a result of denudation, apart from any other cause. Much more of the buccal surface of $\frac{6|}{6|}$ is exposed below the mediobuccal cusp than below the distobuccal cusp at age 8 years.

In the maxillary arch this measurement will increase slightly with age, even though the tooth remains in exactly the same position, on account of the contour of the tooth and its gradual denudation as age increases; the same is true in the mandibular arch, but to a greater degree.

The greatest buccolingual width of $\frac{D|}{D|}$ (i.e., of the teeth themselves), exposed in the normal healthy mouth, varies with age as a result of denudation. Figures of an actual case, measured on the models (Figs. 3, 4 and 5) are:

AGE	WIDTH (BUCCOLING.)		AGE	INCREASE
4-0	$\underline{D\|}$	8.375 mm.		—
9-2	$\underline{D\|}$	9.250 mm.		0.875 mm.
20-0	$\underline{4\|}$	9.875 mm.	4 to 20 ($\underline{D\|}$ and $\underline{4\|}$)	1.500 mm.
			9 to 20 ($\underline{D\|}$ and $\underline{4\|}$)	0.625 mm.

AGE	WIDTH (BUCCOLING.)		AGE	INCREASE
4-0	$\overline{D\|}$	6.750 mm.		—
9-2	$\overline{D\|}$	7.875 mm.		1.125 mm.
20-0	$\overline{4\|}$	8.175 mm.	4 to 20 ($\underline{D\|}$ and $\underline{4\|}$)	1.425 mm.
			9 to 20 ($\underline{D\|}$ and $\underline{4\|}$)	0.300 mm.

The measurements are given to three decimal points because they are the averages of measurements made by two observers.

*B = Breadth.

The amount of increase in width of $\underline{4}|$ over $\underline{D}|$ depends on the age at which the measurement of $\underline{D}|$ is made, being more than twice as great at the longer interval in the above case.

Black[1] gives the following measurements of buccolingual diameter ("the greatest diameter of the crown in the direction named"):

			INCREASE IN WIDTH OF
$\underline{D}$ 8.5 mm.	$\frac{4}{}$	9.1 mm. average 10.0 mm. maximum 8.0 mm. minimum	$\underline{4}$ (average) over $\underline{D}$ = 0.6 mm.
$\overline{D}$ 7.0 mm.	$\frac{}{4}$	7.7 mm. average 8.0 mm. maximum 7.0 mm. minimum	$\overline{4}$ (average) over $\overline{D}$ = 0.7 mm.

It is presumed that Black's measurements were made on extracted teeth.

The fact that none of the buccal surfaces are vertical or parallel increases the difficulties of making measurements.

Canine measurements have not been recorded; the work of other investigators shows greater breadth increases in this region than elsewhere. Lewis[6] says: "The deciduous arches become wider, to allow for the increased size of the permanent incisors, the greatest increase occurring after the age of 6 years; the greatest increase is in the maxillary canine region." The position at which canine measurements should be taken requires consideration.

Cusps are unsuitable points for measurement, because of the difficulty of measuring at the same point every time; in the case of deciduous teeth these are liable to attrition (Fig. 4), and if this occurs, the point of measurement may have disappeared.

It is more difficult to measure molar and premolar breadth on models (and in the mouth it is to be presumed the difficulties are greater) at the lingual and buccal surfaces than in a sulcus, which would seem to be the situation at which these measurements should be made, because they do not change, and a resting point is provided for the measuring instrument.

Lingual Measurements.—If $\frac{D|D}{D|D}$, $\frac{4|4}{4|4}$ and $\frac{6|6}{6|6}$ remain in the same position during the years of investigation, but the normal denudation of the teeth, which occurs in the course of time, takes place and measurements are made at the gingival margin, these measurements will show a decrease on account of the contour of the teeth; these contours may be seen in Figs. 1 and 5. This is a factor which needs to be considered when breadth is measured from the lingual surfaces as well as when it is measured from the buccal surfaces.

BREADTH OF DENTAL ARCHES AT $\underline{D}|\underline{D}$ OR $\underline{4}|\underline{4}$

The following table is adapted from the report (pages 27, 45, and 50, Facial Growth in Children):

INCREASED BREADTH $\underline{D}|\underline{D}$ OR $\underline{4}|\underline{4}$

	BOYS	GIRLS
Ages 2.5*-4.5	Upper: increase insignificant	Lower: none

*Age 2.5 means 2 5/10 years: the method of expressing age is changed so as to correspond to the method used in the report.

	UPPER	LOWER	UPPER	LOWER
Ages 4.5- 8.5	2.8	1.6	2.66	2.15
Ages 8.0-14.0	2.3	2.2	2.74	2.22
Total	5.1	3.8	5.4	4.37

The buccal surfaces of D | D and 4 | 4 are regarded in the report* as interchangeable as points of measurement; no reason is given for this assumption; might it not be assumed with equal justification that the lingual surfaces are interchangeable; it seems that the latter is more probable than the former (Table I). The measurements in Table I of a case (Figs. 4 and 5) show:

(1) The different result obtained as regarded increase of arch breadth when buccal and lingual measurements are used; and probably

(2) that the lingual surfaces of D | D and 4 | 4 occupy the same position; and

(3) that the change of teeth is not accompanied by bone growth. It seems probable that growth of bone occurs before eruption; in this case D | D breadth increases 2 mm. between 4 and 9 years, that is, before 4 | 4 erupt; the space for permanent incisors between deciduous canines is usually, but not invariably,† large enough when the teeth erupt. (Figs. 1, 6 and 4.)

A further subject for investigation would be to find out whether any of this increased breadth (D | D or 4 | 4) is due to growth, and how much is due to change of teeth. Table I analyzes the case shown in Figs. 3, 4, 5 and 6 with this object in view; the increased breadth of 4 | 4 over D | D, due to *growth*, appears to be not more than 3 mm. and not 5 mm. as suggested in the report (pages 47 and 50, Facial Growth in Children), only 2 mm. increase can be shown to be so caused, leaving 1 mm. increase to be accounted for.

Between 8 and 14 years there is an increase in this breadth (D | D or 4 | 4) of 2.3 mm. (boys), and 2.7 mm. (girls) (page 45, Facial Growth in Children), but the real significance of this increase cannot be assessed, because at the earlier age the first deciduous molar is the point of measurement, and at the later age the first premolar; the latter tooth has a greater buccolingual width than its predecessor (in many cases not less than 1 mm., which is 20 per cent of the total increment in breadth in ten years, ages 3.5-13.5, and this has to be considered on both sides of the mouth, making a total of 40 per cent due solely to the change of teeth); therefore, some of the increase must be due to the change of teeth, and not all of it due to growth, as a reader of the report might infer, because these gains are described as "statistically significant."

*Dr. Matthew Young writes: "I did not intend to convey the impression that the buccal surfaces of D | D and 4 | 4 are interchangeable as points of measurements."

†In one case[4] C | C widened 1 mm. between ages 6-8 and 8-4; at age 6-8 2 1 | 1 2 were imbricated, at 8-4 they were in good alignment. The four mandibular incisors had erupted before the first measurements were taken, so that there has been no change of mandibular teeth during the period observed. In Figs. 6 and 4 C | C breadth increase is 2.25 mm. in four years, age 4 to 9: there are no models to show if there was imbrication of 2 1 | 1 2 at any time. In this case 4 | is wider buccolingually than D | by 1.25 mm.

TABLE I

MEASUREMENTS OF CASE, FIGS. 4, 5 AND 6 (BOY). ARCH BREADTH IN MILLIMETERS

AGE		LINGUAL SURFACE	BUCCAL SURFACE
4-0	D | D	27.0	44.2
9-2	D | D	28.5	46.2
21-0	4 | 4	28.5	49.2
Increase when 4 | 4 replace D | D		Nil.	3.0
| D = 9 mm. | 4 = 10 mm.: difference due to 4 | 4			2.0
Increased 4 | 4 width that may be due to growth			1.0
Increased D | D width 4-0 to 9-2 years			2.0
Increase due to growth			3.0
Increase due to 4 | 4			2.0
Total increase			5.0
Average increase as given in the report			5.1
Increase due to growth, not more than			3.0

This problem may be viewed from another angle. Arches with $\frac{4 \mid 4}{4 \mid 4}$ in position are broader than those with $\frac{D \mid D}{D \mid D}$ in position (ages 9-10.5) by the amounts shown in millimeters in the following table:

	MAXILLA	MANDIBLE
Boys	1.99	1.71
Girls	1.37	2.08

(Table 10, page 50)

It will be noted that the increased breadth in the maxilla corresponds to the increased breadth of 4 | 4 over D | D, as shown in Table I above.

Are these increases due to:

(1) A difference in buccolingual width of the teeth D | D and 4 | 4, which will include differences due to the contour and inclination of the tooth and its degree of denudation?

(2) A difference in position, in the bone, of 4 | 4 to that occupied by D | D?

(3) A growth of bone?

(4) A combination of these and other factors?

The report states that "the results of the present inquiry seem to indicate quite definitely that the dental arches increase in transverse diameter with age in the age interval 8-14 years" (page 50, Facial Growth in Children). The inference the reader would draw from the statistics is that the increased width is the result of bone growth *only*, but sufficient has been said above to show that the evidence on this point is not conclusive.

BUCCAL BREADTH OF DENTAL ARCHES AT 6 | 6 AND $\overline{6 \mid 6}$

Between 8.5 and 12.5 years there is a mean increase, as shown in the following table (adapted from page 45, Facial Growth in Children):

	AGE	$\underline{6 \mid 6}$	AGE	$\overline{6 \mid 6}$
Boys	8.5 to 12.5	1.8 mm.	8 to 13	1.3 mm.
Girls	8.5 to 12.5	1.9 mm.	8 to 13	1.3 mm.

For reasons stated above it is doubtful to what extent the increase, between 8 and 12 years, is due to bone growth, and to what extent to increased denudation of the teeth; and it is anomalous that the increase in breadth is greater of the maxillary than the mandibular molars, whereas one would have expected the reverse, as the mandibular molar buccal surfaces diverge at a much greater angle than the maxillary ones; this is another point that needs explanation—one is suggested below. Between 12 and 14 years there is a tendency for $\underline{6 \mid 6}$ and $\overline{6 \mid 6}$ breadths to increase (page 45), but this extra breadth probably results from exposure of more of the buccal surface and not from growth at all.

It has already been stated that in one case (girl) (Fig. 1) $\underline{6 \mid 6}$ breadth increased 2.50 mm. in 4 years (ages 5-7 to 9-5), and in another case (boy) (Fig. 3) $\underline{6 \mid 6}$ breadth increased 1.15 mm. in $10^{11}/_{12}$ years (ages 9-2 to 20-1). In another case (Fig. 419, "Bennett's Dental Surgery," Vol. I, ed. 2) $\underline{6 \mid 6}$ breadth increased 1.25 mm. between ages 6-8 and 8-5; 1.8 mm. between ages 6-8 and 10-7; and 3.5 mm. between ages 6-8 and 14-6. This brings out what may be more important as regards $\underline{6 \mid 6}$ breadth—that as great or a greater increase of $\underline{6 \mid 6}$ breadth takes place at an age earlier than is dealt with in the report as occurs during the period dealt with.

LINGUAL BREADTH OF DENTAL ARCHES AT $\underline{6 \mid 6}$ AND $\overline{6 \mid 6}$

(Both sexes.) (Page 49, Facial Growth in Children.)

The following table is given to show that the internal breadth of the dental arch shows a smaller increase than the external or buccal breadth.

AGE IN YEARS	$\underline{6 \mid 6}$	$\overline{6 \mid 6}$
8-10	34.1	32.6
10-12	34.9	33.1
12-14	35.6	33.2
8-14 Increased breadth	1.5	0.6

Two further points may need to be considered when making and comparing breadth of the dental arch at $\frac{6 \mid 6}{6 \mid 6}$.

(1) The process of eruption includes the adjustment of opposing teeth in occlusion, the effect of the action of their inclined planes on one another; the lips, cheeks and the tongue may also play a part in effecting this adjustment; it would seem that measurements may not be accurate until the teeth are in occlusion; these considerations apply to $\frac{5 \mid 5}{5 \mid 5}$, $\frac{4 \mid 4}{4 \mid 4}$, and $\frac{3 \mid 3}{3 \mid 3}$, as well as to $\frac{6 \mid 6}{6 \mid 6}$: also to deciduous teeth if used for measurement during the period of eruption.

(2) The dental arch converges toward the front, $\frac{6 \mid 6}{6 \mid 6}$ move medially when $\frac{E \mid E}{E \mid E}$ are lost; does any narrowing of $\underline{6 \mid 6}$ and $\overline{6 \mid 6}$ breadth during the 8-12-year

period occur on this account? It would also be some explanation of why $\underline{6 \mid 6}$ breadth increases less than $\underline{6 \mid 6}$ breadth, as the former move rather more medially than the latter.

$\overline{C \mid C}$ breadth increases less than $\underline{C \mid C}$ breadth (unless the bite opens), but is compensated for by forward movement of the mandible;[2] may not a continuance of this process account for the lesser increase of $\overline{6 \mid 6}$ breadth than occurs in the maxillary arch? This is a similar process to that just described, but in the former the teeth fill up spaces by moving through the bone; the latter is a movement of the mandible as a whole with the teeth, or all the teeth, as a whole, through the bone.

FACTORS WHICH MAY AFFECT ARCH BREADTH MEASUREMENTS, BUCCAL AND LINGUAL, AT AGES 2-5 AND 8-14

General.—Contours and inclinations—vertical and horizontal—of buccal and lingual surfaces of $\frac{6\,D \mid D\,6}{6\,D \mid D\,6}$.

None of the surfaces are parallel, or plane surfaces, or at right angles to the line of the arch.

Variation in degree of denudation of these surfaces.

Difficulty of locating a definite spot on such surfaces.

Accessory cusps.

Whether the teeth are at right angles to the line of the arch, or inclined to it, may be a factor.

Deciduous Teeth.—Attrition.

Change of angle of the tooth to the dental arch, i.e., buccolingual inclination.

Rotation, mediodistal, of the tooth in the dental arch.

Loosening.

Permanent Teeth.—$\frac{6 \mid 6}{6 \mid 6}$ should be in occlusion as close as their mediodistal positions permit before being used for measurements.

$\frac{6 \mid 6}{6 \mid 6}$ move medially when $\frac{E \mid E}{E \mid E}$ are lost.

The entire mandible is probably moving forward, carrying all the teeth with it; also there may be medial movement of all the teeth through the bone; the change of $\overline{E\,D\,C \mid C\,D\,E}$ occlusion (Figs. 1, 2, and 3) shows that a movement of this character is occurring.

Deciduous and Permanent Teeth.—The more $\underline{4 \mid}$ buccolingual width exceeds that of $\underline{D \mid}$, the greater will the arch breadth be if the buccal surfaces are used for measurement.

The buccolingual width of teeth varies both anteroposteriorly and vertically.

Measurements of the character used for the report must be difficult to make in children's mouths; measurements from a sulcus or fossa would be less difficult.

CONCLUSION

There appear on page 45 of the report the words: "On account of the lack of agreement as to the points of contact for measurement adopted by different observers. . . ."

This suggests that agreement among workers as to the most suitable points of measurement is a necessity; a sulcus or fossa is suggested as best for cheek teeth, and the buccal surface for canines, with precautions against error, e.g., two observers and/or more than one point of measurement.

Growth of arch breadth cannot be determined except by the use of the same teeth, not by successive teeth. Earlier measurements of $\frac{6 \mid 6}{6 \mid 6}$ breadth are necessary, to show if increased breadth is occurring there when it is taking place in $\frac{D \mid D}{D \mid D}$ region. $\frac{C \mid C}{C \mid C}$ breadth is also desirable; this would provide evidence over the entire period when $\frac{6\,E\,D \mid D\,E\,6}{6\,E\,D \mid D\,E\,6}$ are present and no local causes are affecting the position of $\frac{6 \mid 6}{6 \mid 6}$, except medial movement of the mandible as a whole.

An investigation of abnormal occlusion is now taking place, and it is hoped that the points brought out may be taken into consideration.

It has been pointed out that if the teeth $\frac{6\,E\,D\,C \mid C\,D\,E\,6}{6\,E\,D\,C \mid C\,D\,E\,6}$ remained in the same position, but normal denudation took place over the age period of the report, arch breadth in the case of:

Lingual measurements would show decrease in arch breadth.

Buccal measurements would show increase in arch breadth.

Therefore such measurements should be used only if they can be made at the corresponding point every time.

It is hoped that the matters discussed above will enable research workers to eliminate possible sources of misinterpretation and error. The report shows in a remarkable way how the statistical method yields the same result as an individual case in the normal occlusion series; it is doubtful if the literature of dentistry provides anything at all comparable.

NOTES ON DENTAL ARCH BREADTH AND LENGTH

Figs. 3, 4, 5 and 6 illustrate a further point: that at age 9-2 the maxillary deciduous canine breadth—mediolingual aspect—is exactly the same as the permanent canine breadth, but an increase in breadth of 3.50 mm. has taken place during the previous five years;* this has given more than sufficient space for the incisors which are slightly separated; but further growth is required for the accommodation of the distal aspect of $\underline{3 \mid 3}$ which is provided by the increased width of $\underline{6 \mid 6}$ and $\underline{4 \mid 4}$ after their eruption, otherwise further growth for the accommodation of the premolars and canines is not required: this accommodation is provided by the unimpaired deciduous molars and canines (probably plus some incisor spacing, e.g., in Fig. 1 $m \mid \underline{2\,C}$ are spaced, in Fig. 3 $\underline{1 \mid 1}$ and $\underline{C\,2 \mid}$ are spaced).

*In Figs. 6 and 4 the deciduous canine measurements of arch breadth were found difficult to make with accuracy: the maxillary ones were taken by two observers at three different points, but the increased $\underline{C \mid C}$ breadth (denudation had taken place) did not agree in any instance; it has been averaged at 3.50 mm., which agrees almost exactly with the measurements made in 1914.[2] The mandibular ones were also difficult; the teeth appear to have changed their inclination and show signs of marked attrition. The increased $\underline{C \mid C}$ breadth is now given as 2.25 mm. (In 1914 it was recorded as 4 mm., which would appear to be incorrect.) Loosening of deciduous teeth may need to be considered when making measurements.

It is a point frequently overlooked that if the deciduous molars are present and unimpaired, the space for the premolars is always present, whether the arches are too small or not, i.e., deficiency of length of arch is not apparent in this area of the arch except for a local reason.

Increased breadth of arch after age 4 is necessary for the accommodation of the incisors; it is uncertain whether increased length by growth is necessary for this purpose; in any case, it must be very slight; the extra length of the arch is largely provided by the change of shape, inclination and length of the four permanent incisors compared with the deciduous ones.[5] If there is such a thing as forward growth in the maxillary incisor region, its deficiency will have the same effect on the incisor teeth as deficiency of breadth—crowding in the incisor region. Tomes[10] suggests that the closure of the premaxillary suture of man at birth and little or no forward growth in the maxillary incisors region are correlated facts; in the apes this suture closes much later, or not at all, and these animals have marked increased length in the maxillary incisor region, apparently due to growth in length of the intermaxillary bone.

PROVISION OF ACCOMMODATION FOR THE PERMANENT CANINE

Black's[1] measurements give the increase in size of the maxillary permanent canine over the maxillary deciduous canine as 0.6 mm., so that the amount of extra space to be provided for 3 | is small (in the case shown in Fig. 3 the difference is 0.75 to 1 mm.); it may be provided by some of the excess deciduous molar space and by the further increase of arch breadth after 2 1 | 1 2 are in position (already referred to), as well as by any excess space in the incisor region due to previous growth across C | C: probably less than 0.5 mm. on each side of the deciduous canine is required to give the additional accommodation required, which partakes partly of length and breadth owing to the position of 3 | 3 in the arch.

The shape of the canine—a double wedge with one apex directed lingually and the other directed occlusally—facilitates this tooth's coming into position and occupying a space which at times may appear too small for it.

It would appear that the medial surfaces of the deciduous canines at 9 years of age are a fixed point in the arch, as far as any part of the arch can be so described; if the permanent canine closes incisor spaces, then its medial surface is more forward (and perhaps infinitesimally, but not necessarily more lingual than that of its deciduous predecessor). These considerations suggest that actually the center of C | and that of 3 | occupy the same position, but this point is not so readily accessible as the mediolingual corner. If the medial surface of 3 | is more forward than that of C |, then it would seem that 2 1 | 1 2 must also be more forward than B A | A B at 6 years of age, in order that the curve assumed by the six anterior teeth is similar; from this it would be inferred that there is forward growth in the maxillary incisor region.

CALCULATION OF THE NORMAL DECIDUOUS ARCH

It is suggested that the normal length and breadth of the maxillary deciduous arch may be calculated from the width of the maxillary deciduous

central incisor plus spaces* in the case shown (Figs. 3, 4, 5 and 6) at age 4 years, four times the resultant gives the breadth and the length of the arch as defined (Fig. 6).

MAXILLARY ARCH

$$\left.\begin{array}{l} \underline{|\ A} \text{ width} + \frac{1}{2}\ \underline{B\ A\ |} \text{ space} + \\ \frac{1}{2}\ \underline{A\ |\ A} \text{ space} \times 4 \end{array}\right\} = \text{Length only and breadth only.}$$

Fig. 6.—$\underline{A\ |}$ width = 7 mm.; ½ $\underline{B\ A\ |}$ space = 0.5 mm.; ½ $\underline{A\ |\ A}$ space = 0.25 mm.

Definition of:

Length. $\underline{A\ |}$ medioincisobuccal corner to $\underline{E\ |}$ mediobuccal cusp.

Breadth. $\underline{E\ |\ E}$ gingival margin just in front of mediolingual cusps where there is a minute sulcus.

These two measurements, length and breadth, are the same (Fig. 6).

Fig. 6 is the same case shown in Figs. 3, 4 and 5 and may be regarded as typically normal; Dr. Matthew Young says he "would expect some variation in a ratio about 4 (though perhaps not such a wide variation as in the ratio for the lower arch [5.14]," as given below), to be applicable to the calculation of the normal deciduous arch. In other words the ratio for the maxillary arch in normal cases will vary between figures which are rather less than, and greater than, four.

MANDIBULAR ARCH

$$\left.\begin{array}{l} \overline{A\ |} \text{ width} + \frac{1}{2}\ \overline{B\ A\ |} \text{ space} + \\ \frac{1}{2}\ \overline{A\ |\ A} \text{ space} \times 5.14 \end{array}\right\} = \text{Length only and breadth only.}$$

Fig. 6.—$\overline{A\ |}$ width = 4.5 mm.; ½ $\overline{B\ A\ |}$ space = 0.5 mm.; ½ $\overline{A\ |\ A}$ space = 0.25 mm.

Definition of:

Length. $\overline{A\ |}$ medioincisobuccal corner to $\overline{E\ |}$ mediobuccal sulcus occlusal edge.

Breadth. $\overline{E\ |\ E}$ gingival margin just in front of mediolingual cusps, where there is a minute sulcus.

These two measurements, length and breadth, are the same.

Three cases have been tested (Figs. 1, 2 and 6): in the case of the maxillary arch the ratio was found to be exact; in the case of the mandibular arch there was no uniformity in the results; notes are appended to these mandibular measurements which may, to some extent at least, account for the discrepancies.

The actual measurements from which the ratios are obtained are:

MANDIBULAR

$\underline{A\ |}$ WIDTH

FIG.	RATIO	AND	SPACES	=	LENGTH OR BREADTH	
1	4	×	7.20	=	28.75	28.75
2	4	×	7.50	=	30.10	30.10
6	4	×	7.75	=	31.00	31.00

*The width of the spaces between the different teeth varies in different cases, sometimes greater between $\underline{A\ |\ A}$ than elsewhere (Fig. 1); sometimes greater between $\underline{B\ A\ |}$ than between $\underline{A\ |\ A}$, or these may be equal (Fig. 6).

MANDIBULAR

FIG.	$\overline{A\,|}$ WIDTH RATIO AND SPACES			=	LENGTH OR BREADTH	
1	4.6	×	5.70*a*	=	26.00	26.50
2	6.8	×	4.00*b*	=	27.20	27.20
6	5.1	×	5.25	=	27.00	27.00

a $\overline{1\,|\,1}$ are erupting.
b Age 3-10: mandibular incisor spacing almost nonexistent.

It is sufficient if the ratio is correct for the maxillary arch, as the condition of the mandibular arch may be diagnosed from that of the maxillary one.

In the case of abnormal arches without spacing, or too little spacing, it will be necessary to estimate what the spacing should be if it is desired to estimate the size of the arch.

It is important to include the incisor spacing with the width of $\overline{A\,|}$. Northcroft[7] has stated that "the permanent teeth which succeed deciduous teeth of from 6.1 to 6.5 mm. in width are wider than their predecessors by 38.7 per cent, whereas the permanent teeth which succeed deciduous teeth of from 7.2 to 7.5 mm. in width are only 31.1 per cent wider than the deciduous teeth." It is probable that large deciduous incisors have less spacing than small ones. These considerations would tend to keep the ratio correct.

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DISCUSSION

Mr. G. Northcroft said that so old a member of the Society as Mr. Chapman must have forgotten more than he, the speaker, had ever known, but he thought it well to point out that Sim Wallace had drawn attention to the increase in width between the first permanent maxillary molars after eruption, and that Sir Frank Colyer, later on, illustrated measurements on millimeter paper of his own children's mouths, which showed the increasing width of the palatal distance between the first permanent maxillary molars. He did not know if it had been noticed that the deciduous incisors in three of the cases shown were in retroclination, but after the permanent incisors had erupted the direction of the incisors seemed to be vertical —not in retroclination nor proclination. Therefore it did not necessarily follow that because

the deciduous incisors were in retroclination that a Class II, Division 2 case would develop later on. Mr. Chapman had mentioned another interesting point when taking measurements. To have any value, the measurement should be a lingual one—it was the inside measurement of the arch that counted. Some premolars were broader than the deciduous molars, and some deciduous molars were broader than the premolars—the buccal and lingual diameters differed on account of the size of the teeth and not on the size of the arch. Mr. Chapman referred to some work which the speaker did for the Dental Board a long time ago. It concerned the ratio between the size of the deciduous incisor and the size of the permanent incisor. On the average it was found that if there was a big deciduous incisor there would be a correspondingly large permanent incisor, and the small permanent incisor was preceded by a proportionately smaller deciduous incisor.

Miss K. Corisande Smyth said she had had only a few hours' notice of the communication by Mr. Chapman or she would have been able to produce measurements in connection with the question of external and internal arch measurements to which he had alluded. The change to which he had referred was made early in the investigations concerned, and the whole thing at that stage was rather dark to her. She was simply told that the change from the internal to the external measurement was to be made. But at the time she took a series of measurements both of the internal and external arch breadths of the same cases. Dr. Young had that series available, and if she had had time she would have produced them that evening. She thought that thirty or forty cases were measured, both internally and externally. Some question was raised as to the lingual inclination of the molars, particularly of the mandibular molars, being the factor which influenced the change. It might have been thought that the slightest increase of lingual inclination decreased the internal arch breadth.

Mr. O. N. Catchpole said that if a tooth was succeeded by a broader tooth, surely half that breadth was on the inner side of the center, so that there would be a gain of only 0.5 mm. with each tooth, and the whole gain would be 1 mm., and not 2 mm. as Mr. Chapman had suggested.

Mr. H. G. Watkin suggested that the growth was brought about by the increasing size of the tongue. As Miss Smyth had mentioned, the molars gradually became straight again as a result of increasing internal pressure.

Mr. Harold Chapman, in reply, said that he was glad to hear Mr. Northcroft tell them that the premolars could be either narrower or broader buccolingually than their deciduous predecessors. It only went to show that when examining a few cases one was likely to fall into error, because he himself did not think he had measured one in which the premolar was smaller, and he believed this condition must be much less common than the other. With regard to retroclination, he thought that all mandibular incisors must tend to show retroclination with such overbite.

Mr. Northcroft said that he meant the maxillary.

Mr. Chapman said that Friel had shown that normally one would have what might be regarded as a tendency to retroclination in the deciduous incisors on account of their shape, which is very different to that of the permanent ones; this is one reason why the larger permanent incisors are able to be accommodated in an arch only a little larger than the deciduous arch. It was true, of course, that previous workers had brought forward the result of investigations on this subject. Mr. Campion had also made premolar and molar breadth measurements, but he did not remember that this principle had been brought home to him in such a concrete form as in the report which he had reviewed in his communication. What struck him more particularly was that the measurements of the molar increase which were given there as taking place after eight or nine years of age were insignificant as compared with the increase which he believed took place before that age, and if that were so it was an important point which should not be overlooked. He would have thought that a cusp was a better point for measurement than either the buccal or the lingual surface on which it was

almost impossible to find a fixed point. He had referred to the inclination of the teeth in his written communication, but he had not read it. Mr. Catchpole had made a good point. His own argument was that if the lingual measurements had been taken they would have given smaller measurements and not shown any increase (they might show a decrease); so whichever way it was taken, it did not negative the facts he had put before the meeting. Mr. Catchpole might be right. If the premolar came down exactly where the deciduous molar had been then one got, say, 0.5 mm. increase buccally, and 0.5 mm. decrease in breadth lingually on both sides. With regard to Mr. Northcroft's point, he was not sure whether he understood him correctly, but his recollection of Mr. Northcroft's lecture on "The Growth of the Jaws," was that he stated that the permanent central incisors were always larger than the deciduous central incisors, but that the increase in width, when one had a large deciduous central incisor, was relatively not as great as the increase when the deciduous central incisor was small.

DEVELOPMENT OF TEETH AND JAWS*

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WHETHER one is atheist or infidel, Mohammedan or Confucianist, Jew or Christian, one cannot help feeling that there is some supreme being who rules the universe when one begins the study of the development and growth of the human body, for no piece of machinery is more wonderfully constructed or more perfectly run than it is. When we go into its formation, we are appalled at its complexity, and wonder that there are not more freaks and monstrosities.

As the alchemists believed that gold could be made from the baser metals, so did the Greek students believe that living matter could be made from non-living material. "It required fifty years of work on the cell theory for Virchow in 1850 to propound his thesis that all living cells are derived from a pre-existing cell, and so establish the continuity of life, which has flowed on from the beginning in an uninterrupted stream, each individual being only a period."[7]

Modern embryology, while comparatively new (its history going back to the construction of the compound microscope), was preceded by a certain amount of study made in a crude sort of way. Aristotle (384-322 B.C.) was familiar with the development of the chick, studying the eggs from day to day. He also was one of the students who upheld the theory that living animals came from "slime and decaying matter."[1]

Harvey in 1651 and Malpighi in 1673, after using the hand lens for study, published their findings on the development of the chick, and in 1677 Leeuwenhoek reported the discovery of the human spermatozoon. In 1827 Von Baer discovered the mammalian ovum.

In 1839 Schleeden and Schwanu established the fundamental principles of the cell theory. According to their theory, all organisms were composed of one or more units called cells, which lived a more or less independent life, and yet contributed with their fellows to the general existence of the individual. The human body, then, is a community made up of many individual units, each of which lives an independent existence, and yet contributes to and shares in the general well-being of the body.

Embryology, in its general sense, is the term applied to the growth and development of an animal from the egg to adult age. In the usual sense, however, it is the growth and development that occurs before birth. At birth, however, growth does not cease. It simply marks the time when the animal has arrived at the place in its development when it is ready for the environment outside the mother's body. It must be cared for and nourished, and undergoes growth changes that continue until adult age is reached. The teeth and jaws are among the last parts of the body to become fully developed.

*Presented to the American Board of Orthodontia.

Most multicellular animals form as the result of the union of two ripe cells, the spermatozoon or sex cell of the male and the ovum or egg cell of the female.

All cells contain certain parts that are common or typical to every other cell, namely cytoplasm and the more important nucleus. The nucleus in turn is made up of a nucleolus and chromatin network. The nucleus is essential for a cell to reproduce.

Cell division may take place by either direct or indirect division. In direct cell division, which is somewhat rare, the nucleus becomes constricted at the center and separates into two parts; this is followed by a division of the protoplasmic mass into two daughter cells somewhat smaller in size, but which grow to the original size.

Indirect cell division, or karyokinosis, is characterized by a complex change in the nucleus, which finally divides followed by cleavage of the cell protoplasm. The chromosomes separate out into a definite number characteristic in different animals, and ultimately divide into two equal groups, one group going to each of the two new cells.

Fertilization consists in the union of the spermatozoon and the mature ovum. In man nothing is known of the fertilization of the ovum, as the earliest fetus to be studied is the Miller ovum, which was fourteen days old. From other animals that we have been able to study, however, we assume that the cell from the male enters the cytoplasm of the ovum, where it loses its characteristic form and assumes a typical nucleus form, giving two nuclei within the ovum. Here chromosomes form, the number from each being half the number typical of the species. They are arranged between the centrosomes where a new nucleus is formed, and in the meantime the cytoplasm has divided so that two cells are formed. These two new cells each have a part of the male and female nucleus within it, the former transmitting the individualities of the male ancestors, the latter those of the female ancestors, and by the union of the two nuclei the number of chromosomes is restored to that which was present in the original cell, half having come from each parent.

Early division of the human embryo has not, of course, been observed, but, judging from what we know of lower mammals, we are rather certain that the process starts immediately after the union of the male and female sex cells. Here, then, begins the prolonged series of divisions, which is the first external sign of development and growth. This period of growth is called cleavage or segmentation, and during it the cells are broken up into numerous smaller cells called blastomeres. This is an orderly process of mitosis, and the division increases in rate in geometric progression, though this progression is finally broken down because of the fact that some cells divide faster than others. It should be remembered that since the division is by mitosis each new cell receives its full assortment of chromatic material half from each parent. The resulting mass of cells is called a morula because of its similarity to a mulberry.

The embryo now further advances by separating, leaving a central cavity with a layer of cells arranged around the periphery of the cavity, with the upper or smaller cells forming what we call the animal pole and the lower or larger cells constituting the vegetable pole. This stage is known as the blastula.

In the third stage, or gastrula, which is much the most important of these three stages, the cells at the animal pole multiply much faster than those at the vegetable pole, and there is an invagination or buckling over with the formation of the gastrula or stomach stage, which gives a double-walled bell- or cup-shaped affair, with an inner layer of cells, the entoderm and an outer layer, the ectoderm. The cavity formed by this invagination is called the gastrocele or archenteron. The gastrocele communicates with the outside by an opening, the blastopore.

By the union of the lips of the blastopore, a primitive streak is formed which elongates in the line of the long axis of the developing embryo. The cells on the underside of the streak proliferate, and spread both laterally and caudally, and there is the formation of a third layer of cells, the mesoderm. From the anterior part of the primitive streak, a head process is formed, which extends forward. The roof of the head process for a time is closely associated with the mesoderm, but finally it separates and becomes the rodlike notochord, which eventually becomes the vertebrae column and assumes a position between the nervous and the digestive systems.

With the formation of these three distinct layers of cells, a rudimentary body is formed with the ectodermal layer covering the entire body and giving rise to the nervous system, the entodermal tube, which forms the digestive tract and later the respiratory tract, and finally the mesoderm, which forms muscle and connecting tissue.

This entodermal tube extends first into the head region as the foregut and then posteriorly as the hindgut; the part between, which in man is of brief existence is called the midgut. The foregut becomes the mouth, pharynx, and digestive tube to a place well along the small intestine. At each end this entodermal tube or gut comes into contact with the ectoderm, and the fused plate produced by this union is called the oral or pharyngeal membrane. "The oral membrane makes a floor to an external depression known as the oral fossa or stomodeum, this fossa is bounded by the frontonasal, maxillary, and mandibular processes, and is brought into existence by the overgrowth of these parts. At the beginning of the fifth week, the oral membrane ruptures and the oral fossa and foregut merge. The oral fossa develops into the frontal part of the mouth, which is therefore ectodermal."[1]

In the development of the face it is necessary to mention something about the branchial arches, which correspond to the gill arches of the fishes. There are five of these arches in the human embryo, separated by four ectodermal grooves. The face is formed from a bulging part of the forebrain, which is called the frontonasal process and forms much of the forehead, septum and bridge of the nose. The first branchial arch or mandibular arch has bifurcated into maxillary and mandibular processes. The mandibular parts unite to form the mandible. The olfactory pits cause the frontal process, which is now growing forward between the maxillary buds, to divide into the median and lateral nasal processes. Finally the median nasal processes fuse with the maxillary process, and with each other to form the upper lip. The lateral nasal process joins, also, the maxillary process on the same side, and forms the wings and

margins of the nose and the cheek region also. This development of the face occurs between the fifth and the eighth weeks. When any one of these parts fail to unite, there is a cleft of one kind or another.

The origin of the teeth is from two sources. The enamel has its origin in the ectoderm, and from the mesoderm comes the dentin, cementum, and pulp.

About the sixth week we see the beginning of an epithelial thickening near the free margin of the jaw. This thickening continues along the entire ridge and represents the beginning of the epithelial portion of the tooth and gingivae. At the seventh week it divides into an outer labial lamina, which lies just peripherally to each future upper and lower gum and an inner band, known as the dental lamina, which grows deeper into the substance of the primitive gum.

From this dental lamina, we find ten little buds developing and extending into the mesoderm. They increase in size and assume a budlike appearance outlining the anatomy of the future teeth. These buds become the enamel organs. About the tenth week the buds, of ectodermal origin, begin to press upon a dense accumulation of mesodermal tissue, which, together with the fact that the enamel organ grows fast, causes the enamel organ bud to buckle in and grow around the mesodermal mold, until the enamel organ becomes a two-layered bag or cup filled with mesodermal cells or the beginning of the dental papilla, which eventually will form the dentin and pulp.

The enamel organ is made up of two layers of cells, an outer tunic of cuboidal cells, which flattens out, and an inner layer, which lines the cup like the enamel organ. The inner columnar-shaped layer of cells is composed of the ameloplasts or enamel forming cells of the crown of the teeth. And through them the calcific deposits are laid down in the form of elongated prisms. These cells which cover the root do not aid in depositing enamel around the root. The enamel is laid down from within outward, and the remnant of this enamel organ comes in with the erupting tooth as Nasmyth's membrane.

About the last of the twelfth week, the outer cells of the dental papilla begin to show some activity and arrange themselves into a definite layer. These differentiate into the odontoblasts, which are responsible for the laying down of the dentin. This deposition of dentin, as with the enamel, is deposited first at the incisal and occlusal part of the crown of the tooth, and then progresses rootward, forming in some cases multirooted teeth. The deposition in the dentin takes place, however, from without inward, and after the normal amount of dentin is deposited, the odontoblasts remain throughout life and at various times will lay down additional deposits of dentin, which is called secondary dentin. The remaining mesenchyme, which is within the odontoblasts, forms the dental pulp. Sometimes, however, the odontoblasts become so active that they may even fill up the entire pulp cavity.

During the retreat pulpward of the odontoblasts, they leave branched processes in the dental canaliculi, which have the power of responding to stimulation and change the shape of the odontoblasts which in turn pinch or stimulate the nerve endings which lie between them. This accounts for the fact that dentin is sensitive to grinding, etc.

The mesodermal layer of cells which surrounds the young tooth and immediately approximates it becomes rather specialized and forms a dental sac. This sac, where it approximates the root, develops a layer of cells called cementoblasts, or cementum forming cells, which lay down a layer of specialized bone without any haversian canals, which is called cementum.

Bone, of course, is forming all this time, and the dental sac becomes a thin layer between the cementum and the bony process, or the periodontal membrane, with fibrous attachments to both the cementum and the bony process, which serve to anchor the tooth to the socket.

As the enamel organ assumes its shape, it gradually loses connection with the dental lamina. About the sixth or eighth month the free end of the dental lamina becomes the beginning of the permanent tooth that succeeds the deciduous tooth, and the permanent tooth bud comes to lie internally and below the deciduous tooth.

Posteriorly, the dental lamina sends out a backward portion from which three additional tooth buds are formed, which become the three permanent molars. The formation of the permanent teeth is exactly like that of the deciduous teeth.

Because of this complicated process of tooth formation, is there any wonder that there are frequently supernumerary teeth of both the deciduous and the permanent dentition, or the congenital absence of various teeth? Is there wonder that teeth occasionally erupt without any enamel over them? When one understands how the teeth are formed, one begins to wonder why there are not more anomalies in the masticatory apparatus.

In a recent article, publishing their findings, William H. G. Logan and Rudolf Kronfeld[5] have brought out some interesting data concerning the development of the human jaw and calcification of the teeth. These data are entirely different from the usually accepted facts regarding the time of calcification of the permanent teeth, as set forth forty years ago by Legros-Magitot and reproduced by Noyes and Bödecker, or by Peirce, Black, and Churchill.

Their findings are based on the study of twenty-five human jaws, varying in age from birth to fifteen years (nineteen of which were two years or under) and confirmed by clinical findings in a number of cases of enamel hypoplasia. To quote, "We would like to state that we do not consider the absolute ages of our specimens the most significant item. We are well aware that there are wide variations in the body development even of perfectly healthy children, and consequently more so of sick children, who finally succumb to various diseases. What we wish to emphasize particularly, is the order in which calcification occurs. . . . Far more attention will be paid in our study to this relative order of calcification and development than to the absolute date of the first calcification, which is naturally subject to wide individual variations."

They found that the time of eruption has no connection with the beginning of calcification. Also, that the mandibular teeth tend to calcify slightly ahead of the maxillary teeth. Some of their findings which are of interest will follow.

At birth, in the mandible calcification of the incisal edges and tips of cusps of deciduous teeth has begun, but the cusps are not joined. The teeth in the

maxilla are about the same. There are no signs of calcification of the first permanent molars, though the bony crypt is visible. This shows conclusively that the commonly accepted fact of prenatal calcification of the first molar is incorrect.

Shortly after birth (two to three months), however, the four cusps of the first permanent molar begin to calcify separately, and at three months the cusps of the second deciduous molar are still separated. The cusps of the first deciduous molars, however, have united at the fissures.

Shortly after the beginning of calcification of the first molar, the central incisor begins to calcify. By the age of six months, the crown of the deciduous central incisor is fully formed. The enamel and dentin, along the incisal edge of the permanent central incisor, are visible. The incisal edge of the mandibular lateral incisor has begun to calcify; also the cusp of the permanent canines, though slightly less advanced than the central incisors and mandibular lateral incisors. The four cusps of the first molar have advanced, though not united, and the small epithelial buds of the premolars put in their appearance occlusally and to the lingual side of the center of the crowns of the deciduous crowns. The crown of the first deciduous molars is fully formed, though that of the second is still forming. The maxillary permanent lateral incisors appear as small epithelial buds on the lingual side of the deciduous canine.

By the age of nine months, the crowns of all the deciduous teeth are fully calcified. About the age of one year, or a little later, the maxillary lateral incisor begins to make its appearance as a thin calcified line along the incisal edge.

From its beginning, the calcification of the maxillary lateral incisor goes on at a rather faster rate of speed, so that by two and a half or three years, it has caught up with the central incisor and from then on they continue to calcify at about the same rate. The reason for the delay in calcification of the maxillary lateral incisor is probably due to lack of space in the anterior part of the maxilla, and since it starts off calcifying with its normal mesiodistal diameter, nature has deferred its time of calcification until the jaws have had a chance to develop to accommodate it.

The crown of the first permanent molar has fully calcified. The first deciduous molar has erupted, and the roots of the second are forming. The buds of the premolars are visible, but calcification has not begun.

At the age of eighteen months, the permanent central incisors, canines, and first molars are well advanced, and the maxillary lateral incisor is plainly visible.

At two years of age the crypt of the second permanent molar is formed, and the first premolar cusps begin to show signs of calcification between the roots of the erupted first deciduous molar. The second deciduous molar has erupted, and the crown of the first permanent molar is fully formed.

At two and a half years the four cusps of the second permanent molar are calcified, the crown of the first premolar is well calcified, and the second premolar shows signs of calcification. At four and a half years, the crowns of the first and second premolars and second molars are fully calcified, and spaces between the anterior deciduous teeth should be well formed.

By eleven years the roots of the canines and molars have begun to be resorbed, the bifurcation of the roots of the second permanent molar is seen, and the fully formed occlusal portion of the third molar may be noted.

Table I prepared by Logan and Kronfeld shows their findings and the time of calcification commonly accepted by other students.

TABLE I

MAXILLARY TEETH	LEGROS-MAGITOT REPRODUCED BY NOYES AND BÖDECKER	PEIRCE	BLACK	BRADY	CHURCHILL	LOGAN AND KRONFELD
1	1st month	1st year	1st year	1st year	2 months	3-6 months
2	1st month	2nd year	2nd year	2nd year	2 months	1 year to 15 months
3	1st month	3rd year	3rd year	3rd year	4½ months	3-6 months
4	1st month	4th year	5th year	4th year	3 years	1½-2 years
5	1st month	5th year	5th year	4th year	4 years	2-2½ years
6	6th fetal month	25th fetal month	before birth	25th fetal week	9th fetal week	1-4 months
7	3rd year	5th year	6th year	5th year	4 years	2-2½ years
8	12th year	9th year	9th year	8th year	8 years	7-9 years
MANDIBULAR TEETH						
1	1st month	1st year	1st year	1st year	2 months	3-6 months
2	1st month	2nd year	2nd year	2nd year	2 months	3-6 months
3	1st month	3rd year	3rd year	3rd year	4½ months	3-6 months
4	1st month	4th year	5th year	4th year	3 years	1½-2 years
5	1st month	5th year	5th year	4th year	4 years	2-2½ years
6	6th fetal month	25th fetal week	before birth	25th fetal week	9th fetal week	1-4 months
7	3rd year	5th year	6th year	5th year	4 years	2-2½ years
8	12th year	9th year	9th year	8th year	8 years	7-9 years

"These data show the gross incorrectness of the table of Legros and Magitot. In this table, the same time is given for the onset of calcification of incisors, cuspids, bicuspids and first molars. In reality, the lateral incisor is at least one year behind the central incisors, the cuspids and the first molars, whereas the bicuspids are from two to two and one-half years behind the central incisors and the first molars."[5]

We have seen that at birth there has begun to form in varying degrees of completeness all the teeth except the second and third molars. So much, then, for the development of the individual teeth. Now let us rather briefly discuss the growth and development of the jaws after birth.

We know that at birth the mandible is straight, and as the teeth grow and erupt, the ramus develops and the body of the mandible increases in size. Probably the most authentic work that has been done regarding the development of the alveolar bone and its relation to the movement of the teeth has been done on madder fed pigs by James C. Brash of Birmingham, England, and presented before the British Society for the Study of Orthodontics[3] about 1927. Brash has proved beyond a doubt that the increase in the depth of the mandible and the maxilla of pigs is due to alveolar bone growth. There was some slight growth at the lower border but the alveolar border developed about seven times as fast. Since this is true, there is no difference in alveolar bone and bone at

the base of the mandible, for we see that bone, which was on the alveolar border originally, becomes incorporated in the basal part of the body of the mandible, or the former becomes progressively transformed into the latter.

Summing up his work on the depth of the jaws of the pig, Brash says, "the growth of the alveolar bone is of the greatest, possibly of sole, importance for the general increase in height of both the mandible and maxilla. In the pig, it is in this respect relatively more important in the mandible than in the maxilla, since the chief growth direction in the face is forward and backward to elongate the snout. In the human skull, on the other hand, the relative importance is almost certainly reversed, since there the chief growth direction is downward."[3]

He also has found that there is a continuous deposition of bone to the alveolar walls during the general growth, which causes a constant movement of the teeth upward in the bone; and during eruption the process is practically the same, causing the crypts to rise to a level of the teeth that are already erupted and which are moving at a much slower rate as the crowns are making their appearance. During the process of eruption, the roots are developing or elongating, and at the end of the period of eruption they grow down toward the mandibular canal or the maxillary sinus, but at a slower rate than the crown has grown upward. Another factor contributing to the eruption and growth of the teeth, is the growth of the cementum. Brash also proved in his experiments on madder fed pigs that there is a constant movement of all the teeth in the labial direction, and that the forward movement is due to bone growth. Regarding proximal movement in the anterior border, he has proved from two different sources of evidence, with support from a third, that the teeth move proximally in the alveolar border. The movement is greater in the mandible than in the maxilla, thus facilitating the change in occlusion which is occasioned in the change from the deciduous to the permanent dentition.

Those who are familiar with the eruption of teeth are familiar with the fact that about the time the premolars erupt there is a general opening of the bite or elongation of all the teeth. This he seems to explain by the fact that during the growth period there is a continual addition to the alveolar walls, which causes a constant movement of all the teeth upward in the alveolar border. In summing up the eruption of the teeth he says, "This is the state we call 'eruption,' but in the light of our new conception of the whole history of the continuous movement of all the teeth, it may now take its proper place in that conception as a mere phase of a general process, a phase which requires no special 'theory' to explain. The general process of which 'eruption' is the only part that has always been manifest and has therefore attracted attention, commences with the first formation of the crypt around the developing tooth, continues with the further excavation of that crypt, and its enlargement toward the surface which is continually receding from it, and passes through the stage at which the tooth actually emerges from the bone into the continuation of the same process which is found in the continued rise and other movements of the erupted tooth thereafter with the continued growth of the alveolar bone. The slowing down of the process, when the tooth is 'fully erupted,' is

probably conditioned by contact with opposing teeth, and its final stage may perhaps be found in the further rise and final slow extrusion from the alveolar bone of teeth which are unopposed.''[3]

Earlier in this paper the fact was mentioned that the permanent tooth germ in its earliest stages is necessarily found occlusally from the deciduous germ because the dental lamina extends in a more or less straight line from the oral epithelium to the deciduous germ.

At birth, the tooth germs in the maxilla are lying close to the floor of the orbit. The whole jaw is very low and fairly wide, and the maxillary sinus is visible but appears only as a very small cleft lined with nasal mucosa. As the age increases, the jaw becomes considerably higher and wider, and the sinus increases appreciably in size. By the age of four years all the permanent tooth germs lie above the deciduous predecessors in the maxilla and below them in the mandible, between roots of the preceding deciduous teeth. In his paper on alveolar bone growth Brash helps to explain this unusual movement. During the gradual increase in height of the alveolar process and the growth or eruption of the deciduous tooth, the permanent germ which was originally occlusal to it is passed by the deciduous tooth as it moves occlusally, and left behind, finally coming into position between the roots of its predecessor. We see then that the change in relative position is a combined result of bone growth and of active movement of the deciduous tooth.

Logan and Kronfeld[5] have observed that the arrangement of the tooth germs and the jaws is rather constant and uniform during the first two years of life, and that individual variations do not develop until later years when outer influences and inner tendencies (inherited size and shape of the jaws) become more marked and influential. This, then, brings us back to the union of the two original cells with the equal amount of chromosomes coming from each parent cell. One sees then, that these chromosomes play an important part in inherited tendencies of the individual, since there is always an equal division of the chromosomes in the division of the cells. Hereditary influences are then always present, and the growth of the face and jaws is influenced by the ever present influence of heredity and also the ever present environmental factors, which may or may not help in producing a normal jaw, with normal occlusion or an abnormal jaw with malocclusion and the deformities which may accompany it.

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THE TREATMENT OF OPEN-BITE CASES ASSOCIATED WITH A TONGUE HABIT*

EVERETT ADAMS TISDALE, D.M.D., BOSTON, MASS.

MOST open-bite cases are associated in one way or another with a tongue habit. In one type of case the open-bite exists from some upset in growth factors, a disharmonious balance of secretions from the various endocrine glands that have to do with growth, or a possible hereditary influence. In this type the tongue habit is a secondary factor developing after the open-bite has occurred but helping to maintain or aggravate the condition. In another type of case the tongue habit is a primary factor in developing the open-bite condition. It commences with the curious thrusting of the tongue into a space created by the loss of one or more deciduous teeth, usually the maxillary central incisors, and, as often is the case, augmented by the loss of corresponding teeth in the opposing arch. The loss of these teeth in such cases occurs some time previous to the eruption of their replacing permanent teeth, and by the time their eruption takes place the tongue thrusting has become a habit, a reflex action entirely disassociated with conscious control. Hundreds of times each day the tongue is pushed through the space thus created, and during every swallowing act the strongly muscular tissue of the tongue squeezes through, exerting tremendous pressure upon the newly erupting teeth preventing their coming into contact and so establishing a permanent open-bite condition. Flesher states, "At the time when the deciduous teeth begin to exfoliate the child finds a new playground for his tongue. He finds much delight in making excursions over this mouth with his tongue. He develops a new habit, that of thrusting his tongue through the newly formed opening, or entrance into a new realm of pleasure and thrills. So persistent is he that development in that region does not take place as rapidly as in other parts of the dental mechanism. The anterior teeth are the first to be lost. Here is where the newly found joy asserts itself. The tongue may be thrust through the space frequently, or what is worse, is permitted to rest in this opening when it is not in use. If the tongue is oversize, it will be certain to find this opening and to stay there." It is with this type of case that I wish to deal.

While it is not always possible to differentiate the two types, a study of the surrounding tissues and particularly of that area referred to by Lundström as the apical base will usually lead to a proper classification. In direct contrast to those associated with general growth disturbances, those cases developing directly from tongue pressure present well-formed alveolar support of the teeth and yield to treatment with permanently successful results once the tongue habit is corrected. I wish to offer the following method of treatment for reducing the deformity and overcoming the habit.

*Presented to the American Board of Orthodontia.

Assuming that the occlusion of the posterior teeth is normal and that the open-bite exists only from canine to canine, the first step is to reduce the open-bite and to establish a normal overbite of the teeth. The key to this portion of the treatment is the use of a swivel tube. Ordinary expansion arch wires are used attached through buccal tubes either soldered or pivoted, according to the particular case, to bands on the first permanent molars. If it is decided after a study of the condition that the infraclusion of the incisors occurs only in the maxillary arch and that the mandibular incisors are normal in their vertical relation, swivel tubes are used to attach the maxillary expansion arch to the molar bands and soldered buccal tubes are used for the mandibular attachment. If the conditions are reversed and the mandibular incisors are in infraclusion, swivel tubes are used to attach the mandibular

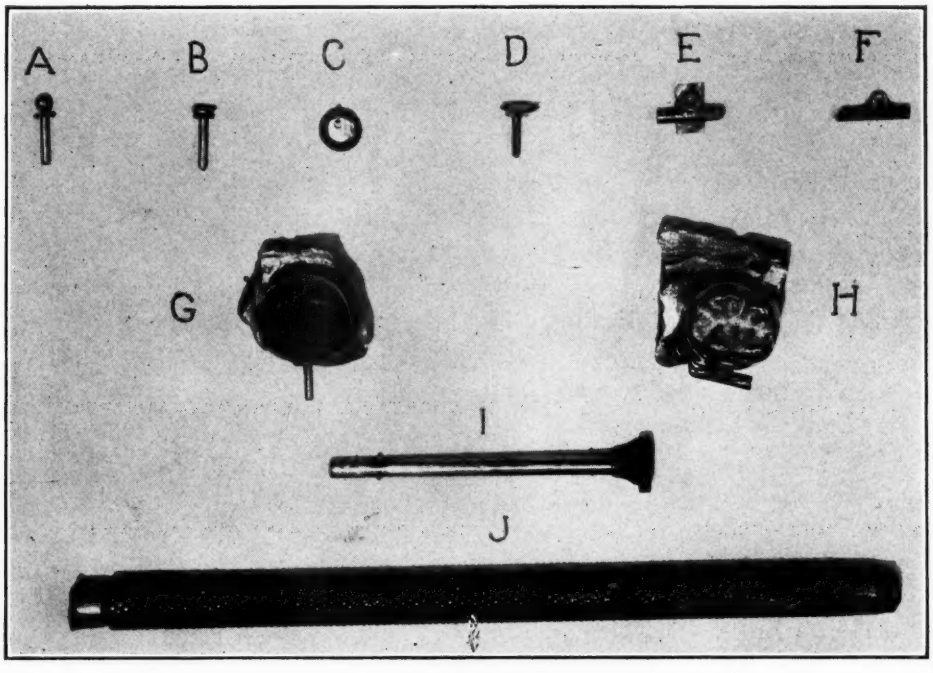

Fig. 1.

appliance. Should both maxillary and mandibular incisors be in infraclusion, the swivel tubes are then used for both arches. The purpose of these tubes is to allow attachment of the expansion arch to the molar bands and to allow free movement of its anterior section in an incisogingival direction without a corresponding tipping of the molar teeth.

The principle of the swivel tube is not new. It was utilized by L. W. Baker in 1914 to allow free tipping of a molar to facilitate its distal movement. Some time later the possibilities of its use in the treatment of open-bite cases became apparent, and since then it has been used in numerous cases of that type with considerable success.

The swivel tube here used is a refinement of Baker's early one. While not on the market, it can readily be constructed in the following manner (Fig. 1):

A piece of 0.045 gold platinum alloy wire is balled on one end (*A*); then the ball is flattened (*B*). A piece of molar band metal is formed to a saucer shape as in *C* by striking it on a lead block by the instrument (*J*). This instrument is made from an old handle with one flat end which is bevelled around the edge giving a circular flat surface about 3 mm. in diameter with a bevelled edge a millimeter wide extending at an angle of approximately 30 degrees. A hole of 0.045 diameter is then bored through the band metal near one edge of the flat surface and the prepared wire inserted in this hole with the flattened end inside of the saucer. These two pieces are soldered together (*D*) and form the staple of the swivel tube.

The tube part consists of a regular buccal tube which is placed on a flat piece of band metal with another short section of 0.045 tubing placed above and at a right angle to it and soldered (*E*). Solder is then flushed around the joint and the excess of band material and right-angle tubing trimmed away and the band metal drilled through to complete the opening of the right-angle tube (*F*).

The two units, staple and tube, are assembled, the staple sliding through the right-angle tube, and placed on the band for the alignment of the buccal tube, this taking its position gingivally to the staple which is then soldered to the molar band (*G*). Instrument (*I*) is a mandrel with a head similar to that of a root-facer with an 0.045 hole in the center so that it may be slipped over the staple to trim away the excess soldered attachment to the molar band and to surface the area at right angles to the staple. It is important that there be a large flat area at the base of the staple against which will rest the flat surface of the buccal tube, made by soldering it to a piece of band metal as explained above, to prevent any side play of the tube. The tube is then slipped to place over the staple which is cut off leaving a slight excess and headed over completing the operation. The result is a "swivel" tube that is stable buccolingually but swings freely in an occlusogingival direction (*H*).

In the treatment of open-bite cases associated with a tongue habit, such as that shown in Fig. 2, any general development of the arches necessary is first obtained and the proper alignment of the teeth in relation to their individual arch is secured. The posterior teeth are placed in normal occlusion, and all that remains is the reduction of the overbite. Having determined that a condition of infraclusion exists only in the maxillary incisor region, bands with swivel tubes are placed on the maxillary permanent first molars and an expansion arch wire is adapted. This arch is attached to the teeth in infraclusion by means of bands on the teeth and some attachment such as the Gove lock, Ketcham hook, ribbon arch bracket, or simple L-shaped pieces of wire soldered to the bands. The mandibular appliance consists of the regulation expansion arch with soldered buccal tubes and some stable attachment to the anterior teeth, preferably to the canines and incisors. Hooks are soldered to both arch wires in the canine region, and small, light, up-and-down intermaxillary elastics are used as the motivating force. In this manner the mandibular teeth offer reinforced stationary anchorage against the mass simple resistance of the maxillary incisors which are to be moved. The maxillary molars through the swivel tube attachment exert no force and offer no

resistance to the action, their part being merely the posterior stabilization of the maxillary expansion arch wire.

The increased efficiency of this method of treatment can readily be seen over that so often used which employs the soldered buccal tubes on both arches, since in those cases the anchorage and the resistance are equal, both being reinforced stationary, and the action is entirely reciprocal necessitating movement of the teeth in both arches together with the very undesirable feature of tipping the molars.

In those cases requiring the further eruption of the incisors in both arches, swivel tube attachments are used on all four molar bands. The remainder of the appliance is similar to that used in the previous type cases.

Fig. 2.

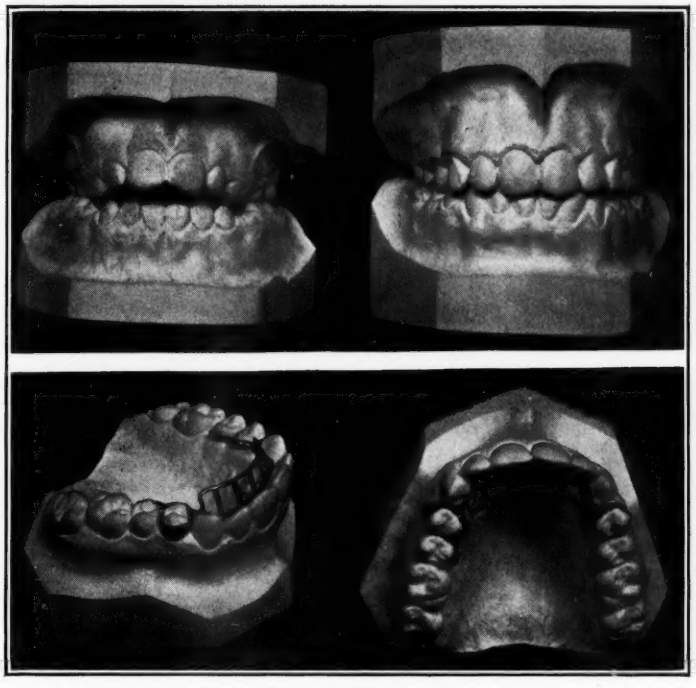

Fig. 3.

The full reciprocal force of the intermaxillary elastics can then be utilized upon the teeth to be moved, which now may be said to afford mass simple reciprocal anchorage, without any drag on the molars.

Through the use, then, of the intermaxillary elastic principle and the employment of properly adjusted anchorage and resistance the desired movement of the teeth can readily be obtained. The teeth which are in infraclusion can be brought down or up as the case may be and a normal overbite established. As is true in the correction of all types of deformities and particularly of those having to do with the forming or shaping of bone, overcorrection is an essential of proper treatment. So in these cases of open-bite, correct treatment should aim to establish a deeper than normal overbite. This having been accomplished, the first part of treatment is done.

The movement of the teeth has been completed, and while the teeth are in occlusion the tongue cannot be forced between them. The habit, however, has not been overcome. As soon as the teeth are slightly parted, the tongue will resume its thrusting movements, and absolute retention of the teeth in their new position will be necessary for an exceedingly long period of time before it can be hoped that they will maintain their corrected relationships. Even then if the cause (the tongue habit) persists, the deformity is more than likely to reappear. Ketcham in a paper on the treatment of open-bite cases says: "I wish to emphasize the fact that it takes two or more years after all retaining appliances have been removed to determine if the treatment of a case is to be classified as successful. This is especially true of overbite cases, for following the period of active treatment and postoperative care there may still be abnormal pressure exerted by the abnormally developed tongue and lower lip, also a lack of pressure from the upper lip. These faults may not have been entirely overcome, even though every effort has been made to train the patient in correct muscle function. . . ." Flesher in discussing this paper remarked, "When there is a partial relapse after the treatment of an open-bite case, I usually find there is an abnormal movement of the tongue."

The cause should be eradicated; the habit should be corrected. Again Flesher states, "I attribute some of the relapses of our cases to the lack of cooperation on the part of the patient and the failure to correct the tongue and lip habits. To correct a habit is not an easy thing to do. It requires the full and persistent cooperation of every one interested in the case or individual."

Many suggestions have been advanced for the correction of these tongue habits. It has been suggested that the patient be taught to place his tongue in a new position and that this be done by means of exercises which the patient performs a number of times each day. Ketcham in the same paper says, "A sincere effort should be made to correct pernicious habits. Muscle training . . . should be definitely carried out." Rogers has shown several cases in which the treatment of open-bite associated with a tongue habit was materially aided by exercising the tongue and obicularis oris muscle. He stated, however, that in some individuals such a result would be impossible by the employment of a like method. And Robison, in discussing Rogers' paper asked, ". . . how are you going to get them (patients) to function these muscles voluntarily 2,000 times daily?" Continuing, he said, "It must be done at least that often in order to develop them. It is almost a physical impossibility to suggest or have them think of them that many times. Therefore, it must become involuntary, and that is where the rub comes."

Granted that the patient will cooperate to the fullest extent desired, however, it is expected that a habit that has been active over a period of years as an unconscious reflex operating many, many times throughout each waking hour of each and every day be corrected by an action that is consciously done for, perhaps at the most, one hour each day, while the habit persists, checked only by the new position of the teeth, the remainder of the time.

Is it not more reasonable to suppose that a definite interference placed in the way of the habit action will condition that reflex and after a period of time set up a new reflex act that will definitely supplant the old one even when the interference is removed?

L. W. Baker presented a paper before the New York Society of Orthodontists in the spring of 1934 in which by means of motion pictures showing the reflex actions of decerebrate and decorticate cats he showed the strong persistence of reflex actions and the dominance of certain stimuli over others. He then suggested the possibility of overcoming the pernicious habits with which we have to deal by placing an interference in the path of the reflex action and by altering the stimulus.

Applying this principle to the correction of the tongue habit an interference or guard is placed lingually to the maxillary incisors projecting below the incisal edges so that with the teeth in occlusion or even slightly apart it is impossible for the tongue to rest or exert any pressure upon the incisor teeth (Fig. 3). During the act of swallowing, the tongue is pressed against this guard and directed against the palate, its normal position during this action, and after a period of time this new position becomes a part of the reflex act. In cases in which the tongue habit has been particularly persistent the edges of the guard may be roughened to strengthen the stimulus to place the tongue elsewhere. A similar principle has been employed by A. Jackson who credits it to Lewis. He has shown a guard attached to a lingual appliance on the mandibular arch. Once the reflex has been changed, the habit has been corrected, and a reasonable period of retention only should be necessary.

In conclusion it is my belief that with the use of the swivel tube to obtain a more favorable type of anchorage for the reduction of the open-bite and with the use of a definite interference to correct the tongue habit the treatment of these cases will be simplified and the prognosis will become more generally favorable.

I wish to express my appreciation to Dr. Lawrence W. Baker and to Dr. Cleophas P. Bonin, who have so kindly allowed me the use of their material in the preparation of this paper.

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LINGUOVERSION OF RIGHT MAXILLARY TEETH*

JOHN A. MCPHAIL, D.D.S., CINCINNATI, OHIO

A GIRL aged nine years presented with a linguoversion of the right maxillary teeth, from the canine to the first permanent molar inclusive.

The teeth on the left side were in neutroclusion. There was a slight protrusion of the maxillary incisors, with quite a marked separation between the maxillary central incisors which was supposedly caused by thumb-sucking. (Fig. 1.)

Fig. 1.

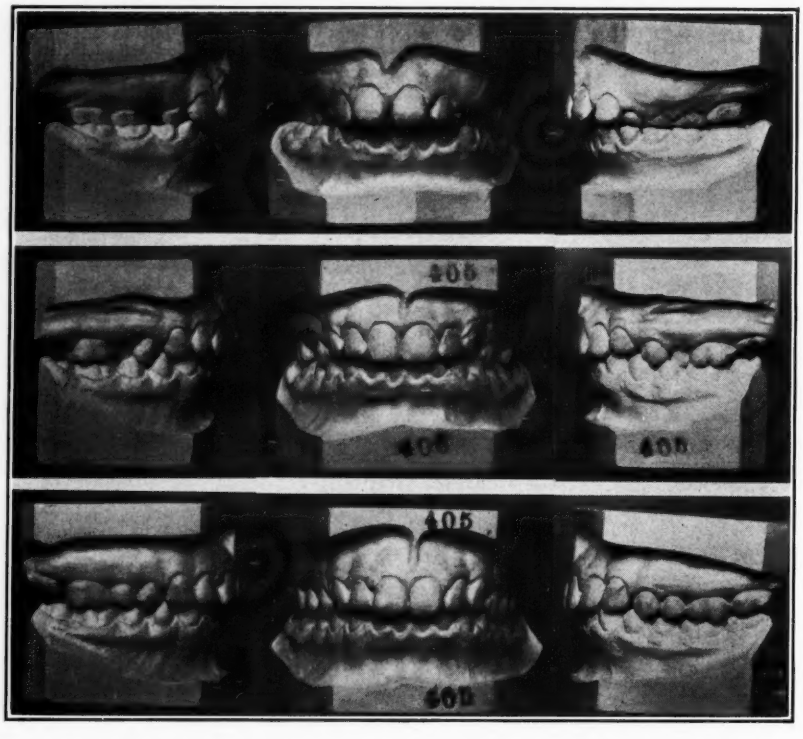


Fig. 2.

Fig. 3.

It was decided to band the maxillary and mandibular first permanent molars and to construct an appliance with 19 gauge lingual wires attached to molar bands on both the maxillary and the mandibular teeth.

A labial arch, with tubes attached to molar bands, was placed on the maxillary denture. A hook was placed on the lingual surface of the maxillary right first molar, and a double hook was placed on the buccal surface of the mandibular right first molar, to which the patient attached small elastics to correct the cross-bite. The arch was expanded by the use of a Lourie wire stretching plier, applied to the maxillary lingual wire. A "kick" was put in the labial arch to assist in this expansion. Intermaxillary elastics

*Presented to the American Board of Orthodontia.

were worn, attached from hooks on mandibular molars to hooks on the labial arch.

After the spaces were closed between the maxillary anterior teeth and the posterior teeth had been brought into normal occlusion, lingual appliances were constructed and used as retainers until the maxillary second premolars emerged through the gums. These teeth erupted too far toward the palatine surface (Fig. 2). Finger springs were added to the appliances to bring them into occlusion.

Fig. 3 shows the case two years after all appliances had been removed.

AN OBSERVATIONAL CASE INVOLVING EXTRACTION OF A SUPERNUMERARY TOOTH IN THE MAXILLARY LEFT CENTRAL INCISOR REGION*

GEORGE R. MOORE, D.D.S., ANN ARBOR, MICH.

HISTORY.—The patient, a boy aged twelve years and eight months, appeared for consultation on April 11, 1929, eight months after the removal of a supernumerary tooth in the maxillary left central incisor region, shown from two angles in the first two radiographs of Fig. 1. The third radiograph in Fig. 1 shows the condition of the central incisor at the time of his first visit, and the first cast in this figure shows the appearance of his mouth at the same

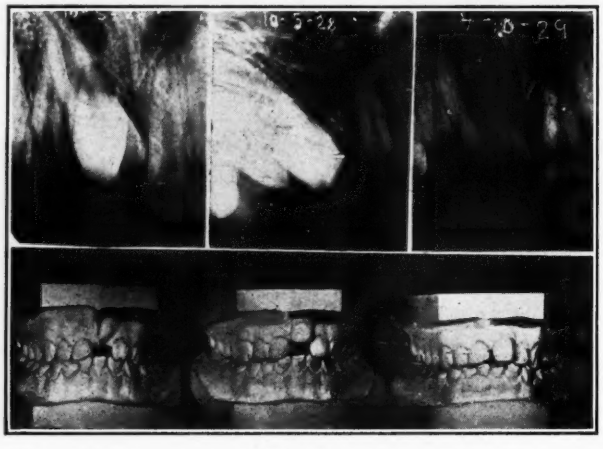


Fig. 1.

time, with the space for the maxillary left central incisor 1.5 mm. narrower than the measurement of the right central incisor mesiodistally. Inasmuch as details of early development seemed to me at that time to be quite irrelevant to this case from the standpoint of service, I neglected to make a detailed inquiry as to his early development. From all appearances, it could not have been very abnormal since the arches were in every other region practically perfectly developed. The maxillary right central incisor had been mutilated, as shown, in athletic encounter.

Etiology.—This malocclusion may be definitely attributed to the presence of a supernumerary tooth.

Diagnosis.—Partial closure of the maxillary left central incisor space associated with tardy eruption of the incisor.

Treatment.—This case was put upon observation, the patient being informed that it was advisable to permit this central incisor to come down of its

*Presented to the American Board of Orthodontia.

own accord, as it did. I took careful measurements of the space with the result that between April and August, 1929, the space had increased 1.5 mm. as the central incisor progressed in the path of eruption. Through the excursion of food over the mucous membrane it had become keratosed, with the result that the central incisor erupted with difficulty. It was decided in November, 1929, to lance the gums transversely along the crest of the ridge in order to encourage the eruption of the incisor in line rather than labial to it as so often happens in cases of this kind. In March, 1930, the incisor was already erupted very satisfactorily, and in December, 1930, the second cast shown in Fig. 1 was made to record its progress. At this time, the boy was instructed to use finger pressure

Fig. 2. Fig. 3.

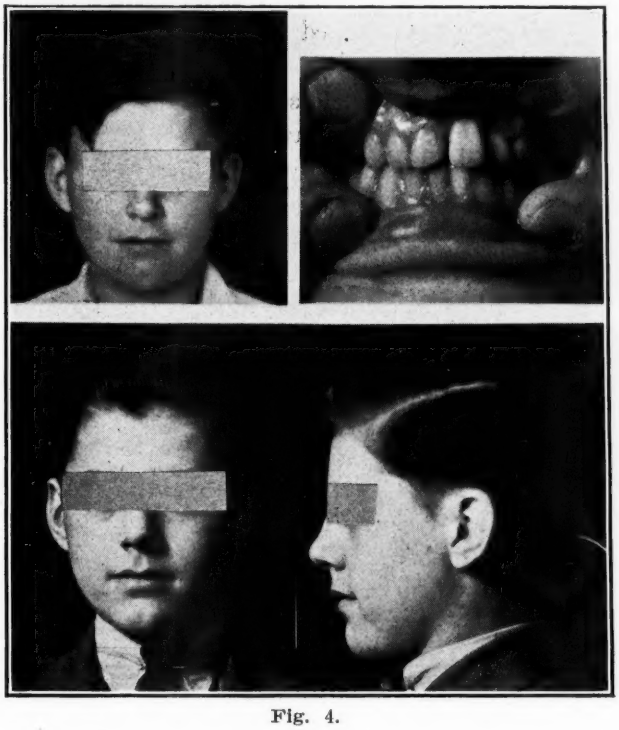


Fig. 4.

against the labial surface as near the cervical as he could apply it, and to guard against using tongue pressure on the lingual surface. This was done with the result shown in the third cast of Fig. 1 taken in September, 1931.

Prognosis.—According to the results achieved so far, the chances for further improvement seem to be favorable. If any active treatment ever has to be instituted, it will necessarily be of very short duration.

From the before and after photographs in Figs. 2 to 4 it will be seen that there is little relationship between this case and facial form. Fig. 2 was taken in April, 1929, and Figs. 3 and 4 in April, 1932. Concern over the case was entirely based upon a decision to eliminate the necessity of artificial substitute in the region and to eliminate unreasonable orthodontic treatment.

TREATMENT OF NEUTROCLUSION WITH LINGUOCLUSION OF MAXILLARY INCISORS*

C. J. Vosmik, D.D.S., Cleveland, Ohio

History.—Girl, aged fourteen years. The dental arches of the father were in normal relationship. Childhood diseases consisted of measles at five years, chickenpox at five and a half years, and pneumonia at eight years. Tonsils and adenoids had been removed at the age of seven years. No history of accidents or vicious habits.

Oral examination revealed cavities in the mandibular right first molar and maxillary right first molar.

Radiographic examination revealed the presence of an unerupted mandibular right second premolar.

Attributed Etiology.—The early loss of the maxillary deciduous canines may be considered the etiologic factor producing malocclusion.

Diagnosis.—Impressions were taken from which casts of the denture were constructed. The malocclusion was classified as a neutroclusion with a linguoclusion of the maxillary incisors and right second premolar.

Fig. 1 shows views of casts at the beginning of treatment, January, 1926.

Treatment.—In order to restore the teeth to a normal functional and anatomic relationship the following plan of treatment was instituted: first, a labial movement of the maxillary incisors and right second premolar into their proper labiolingual relationship with the mandibular teeth; second, a slight movement distally of the mandibular right first molar to provide space for the eruption of the second premolar.

Plain molar bands carrying half round lingual tubes and 0.040 inch buccal tubes were placed on the four first molars. The mandibular dental arch carried a labial wire the right end of which was threaded. Hooks for intermaxillary elastics were soldered to the labial arch. Labial and lingual arch wires were placed in the maxillary dental arch. The lingual wire was removable and carried a simple auxiliary spring, the purpose of which was the buccal movement of the maxillary right second premolar. The ends of the maxillary labial arch were threaded. The distal movement of the mandibular right first molar was accomplished by ligating the labial wire to the incisors and then gradually increasing the length of the arch on the right side by turning the nut. The force of the intermaxillary elastics prevented the labial movement of the mandibular incisors. The maxillary incisors were brought labially by ligating them to the labial wire and then gradually turning the nuts on either side. The maxillary molars were stabilized by the force of intermaxillary elastics.

Results.—The patient presented for treatment January 11, 1926. Ten months later, November, 1926, with the exception of the unerupted mandibular

*Presented to the American Board of Orthodontia, May, 1932.

right second premolar the teeth were established in a normal functional and anatomic relationship. In January, 1927, the appliances were removed, and a soldered lingual retaining wire was placed in the mandibular arch. The mandibular right second premolar having erupted, the retaining wire was removed in May, 1927.

Fig. 1.

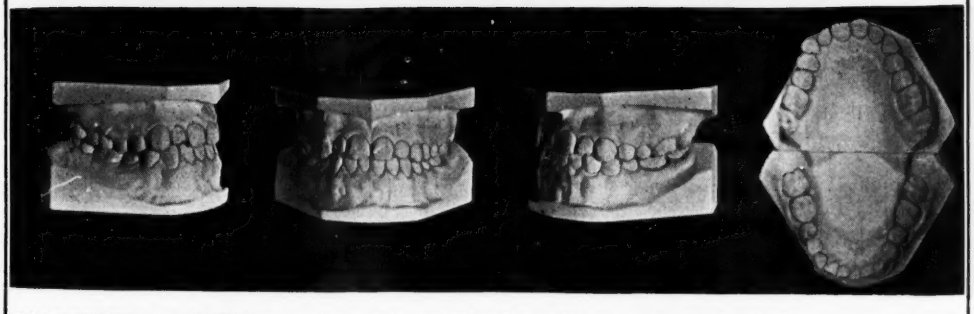


Fig. 2.

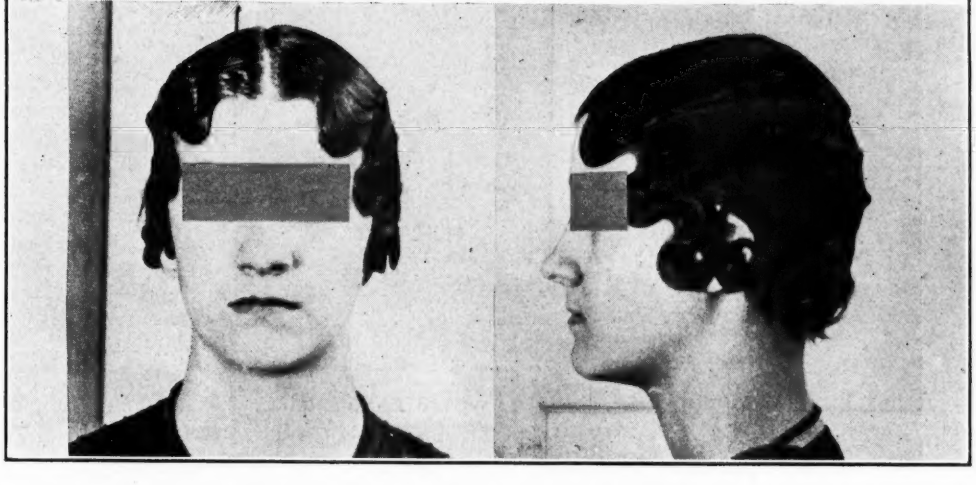


Fig. 3.

Fig. 2 shows views of the cast made in July, 1931.

Fig. 3 shows views of the patient taken in October, 1931.

Prognosis.—The prognosis is favorable that a normal functional and anatomic relationship will be maintained.

NEUTROCLUSION WITH MESIOVERSION OF MAXILLARY FIRST PERMANENT MOLARS

LELAND R. JOHNSON, D.D.S., M.S.D., CHICAGO, ILL.

THE patient, a girl aged nine years and two months, presented for treatment September 28, 1929. Tonsils and adenoids had been removed at eight years of age, and her respiration was normal at the time of examination (Fig. 1).

Fig. 1.

Fig. 2.

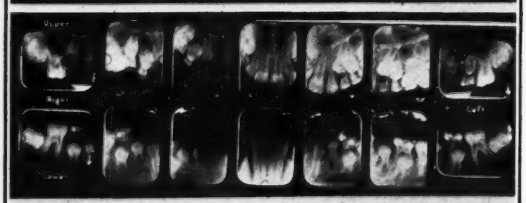


Fig. 3.

A combined tongue and lip habit, which consisted of curling the tongue in the palate while the lower lip was sucked, was present. The labium frenum was normal. Her general health was fair; although at that time her face had many pimples, and she had just had a boil. The deciduous molars were badly infected, and her teeth were more susceptible to caries than the average. In May, 1928, she had had scarlet fever, which was followed by mastoid and its operation. Hygienic conditions of the mouth were poor. The chin was quite prominent, and the mandibular incisors were tipped lingually so that when the lips were closed she presented an edentulous appearance to a limited

Presented at the Thirty-Third Annual Meeting of the American Society of Orthodontists, New York, N. Y., April 30, May 1, 2, and 3, 1935.

degree. The maxillary central incisors protruded, and the mandibular incisors were occluding into the soft tissue of the palate. The maxillary first permanent molars were in mesioversion. The maxillary right second deciduous molar was almost entirely submerged, only a portion of the occlusal surface being exposed. The mesiodistal diameters of the maxillary left deciduous molars had been decreased by caries, and the maxillary left permanent first molar had drifted mesially. An examination of the full mouth x-ray (Fig. 2) revealed the bone apparently developing normally and all permanent teeth present, including the second molars. The third molars were not evident in the x-ray pictures.

Etiology.—The malocclusion in this instance was probably caused by the combined lip and tongue habit described above and by a decrease in the space

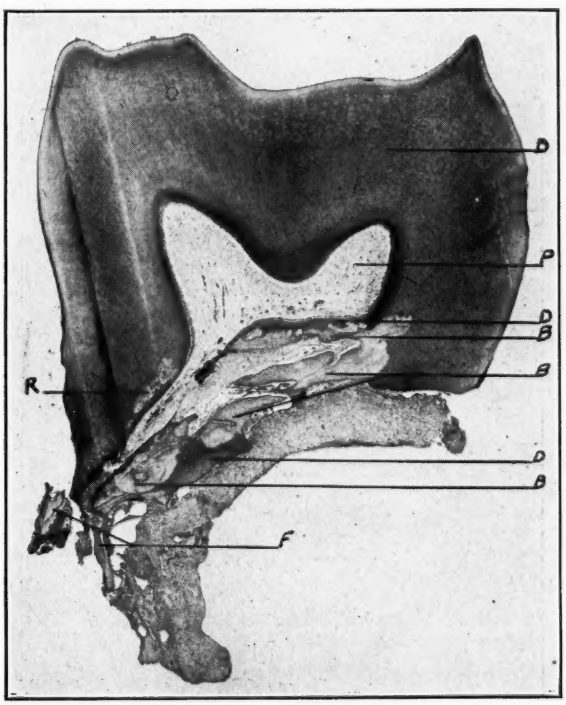


Fig. 4.—A submerged deciduous tooth. The dentin, *D*, is more darkly stained than the bone, *B*, which gradually fills in resorbed portions of the dentin. The bone in the area *F* shows a line of fracture indicating that the tooth was probably ankylosed. Resorption area, *R*, not yet invaded by bone.

occupied by the maxillary deciduous molars due, on the left side, to dental caries and, on the right side, to the submerged maxillary second deciduous molar.

Treatment.—Impressions were taken, and the patient was referred for the extraction of the deciduous molars, with the exception of the mandibular second deciduous molars which showed little absorption of the roots. The appliances used were a labial arch with lingual extensions on the maxillary arch and a lingual arch on the mandibular arch. Force was applied November 1, 1929. The maxillary incisors were moved lingually, the mandibular incisors labially. It was discovered that the submerged molar had not been extracted at the beginning of treatment as thought, and had not been detected because it appeared as an erupting premolar, only one cusp being visible (Fig. 3). The

patient was immediately referred for extraction of this tooth. Histologic examination by Wm. B. Skillen (Fig. 4) showed a probable ankylosis.

Because the patient was leaving the city for the summer, a bite-plate was placed to depress the mandibular incisors and to produce, if possible, a vertical development in the molar region. As soon as she returned, intermaxillary force was employed to force the maxillary molars distally.

Retaining appliances were placed November 12, 1931 (Fig. 5), and consisted of a fixed lingual on the maxillary arch with a spur to maintain space for the maxillary right second premolar which was not fully erupted and a lingual retainer on the mandibular arch with a horizontal round attachment

Fig. 5.

Fig. 6.

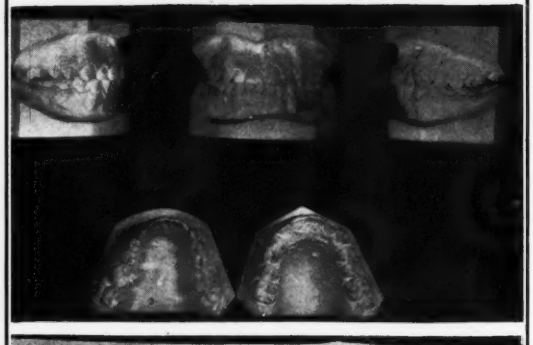
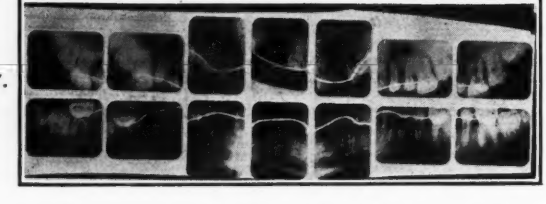


Fig. 7.



on the mandibular right molar and a half round vertical attachment on the mandibular left molar. An attempt was made to improve the position of the mandibular right first molar during retention. The lip habit was broken and the maxillary right second premolar erupted slightly rotated. The retaining appliances were removed December 29, 1932 (Fig. 6). Fig. 7 shows the full mouth x-ray examination after treatment was completed.

The results in this case are very gratifying to the patient and, while not perfect, yet may be considered satisfactory. Additional treatment would improve the occlusion, but the patient objects to further treatment. The facial characteristics are greatly improved, and I believe that the prognosis of this case may be favorable.

INTERCHANGEABLE SNAP-LOCK LABIAL ATTACHMENT AND SELF-LOCKING LINGUAL ATTACHMENT

LANDIS H. WIRT, D.D.S., SOUTH BEND, IND.

IN PRESENTING a new type of alignment arch attachment, it seems proper to enumerate the principal requirements of an ideal orthodontic appliance and to analyze some of the principal types of attachments heretofore in common use, pointing out features in which they fail to meet those requirements.

THE IDEAL ORTHODONTIC APPLIANCE

1. It should provide adequate control over the teeth to be moved, yet permit that freedom of individual teeth which is associated with proper function and is due to the somewhat flexible nature of their attachment to the alveolus.

2. It should accomplish every desired type of individual or group tooth movement.

3. The removable parts should be simply and easily fastened, sufficiently secure so as not to become detached accidentally, but readily removable by the operator.

4. It should be capable of producing an extremely gentle application of force, continuously, over the longest possible period of time between readjustments.

5. It should be as inconspicuous as may be compatible with efficiency, artistic in appearance, and as nearly as possible self-cleansing.

SOME ATTACHMENTS HERETOFORE IN USE

The Angle bracket band attachment was designed for use with the 0.022x0.036 inch ribbon arch. It does not give adequate control over the teeth, especially where they are to be moved bodily to or from the median line. Because of the narrow lateral dimension of this attachment it is very inefficient in rotation of teeth, and the ribbon arch being comparatively large and stiff, the appliance is too conspicuous and permits too little freedom of teeth in their alveoli. In order to keep the force applied comparatively gentle, there can be only short periods of time between readjustments.

The Angle tie bracket attachment was designed for use with the edgewise arch technic. It is too narrow laterally for adequate control of the tooth involved. It often requires the addition of eyelets, spurs, etc., and attachment by means of wire ligatures is neither simple nor easy. Like the ribbon arch, the edgewise arch is too powerful.

The McCoy open tube attachment was designed to snap over round arch wires of 0.036 and 0.040 gauge. It fails of adequate control and requires the

Clinic presented at the Thirty-Third Annual Meeting of the American Society of Orthodontists, New York, N. Y., April 30, May 1, 2, and 3, 1935.

addition of spurs for root movement, and of ties for rotation. The arch wire is snapped into the open tube but requires too much force to seat it, causing discomfort to the patient. Too often it becomes unfastened accidentally. Carrying heavy arch wires, it requires too frequent readjustment and may easily carry too much force.

Johnson twin-wire arch attachment: This is the first real approach to the application of gentle force. It is limited to use on the six anterior teeth, however, and cannot produce bodily tooth movement of any kind except elevation and depression. It is difficult and sometimes impossible to apply to teeth which are far out of alignment. It requires two special pliers to manipulate, and a very awkward manner of holding them. The separate part, which is the means of holding or attaching to the arch wire, is insecure and frequently becomes displaced and lost, thus necessitating additional expense for parts, as well as causing interruption of tooth movement and annoyance to both operator and patient.

INTERCHANGEABLE SNAP-LOCK ATTACHMENT

This attachment, which I present, is designed primarily for use in carrying the finer gauges of wire which produce gentle pressure and continue to act over a longer period between readjustments than those heretofore commonly in use.

Since it is the removable part which carries the arch wire, and this part can be supplied to fit any desired size of arch wire, it thus becomes interchangeable; and one may, if the requirements of the case indicate, change from one size or type of wire to another at any time without removing the bands.

One may produce the action of a rectangular arch wire on any tooth or teeth, while at the same time applying the action of a round wire on any other tooth or teeth.

It has sufficient breadth to give proper relation between the leverage or force applied to a tooth and the resistance to movement, thus providing a more perfect control over the tooth with less strain on the band and the attachment.

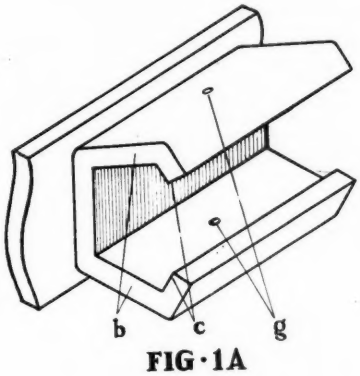
The mechanical principle used in fastening this attachment is similar to that of ice tongs, in which increase of the weight tightens the hold. It is applied by being snapped into place by a very light pressure, which is easily tolerated by the patient; but the ease of insertion does not inversely imply that it will become unfastened while in use, because the removal is effected in a different manner.

The attachment consists of a matrix Fig. 1 *A* soldered on a band in a position at right angles to the axis of the tooth, and made of an elastic material such as clasp gold. The length of the matrix is 0.110 inch and its side walls (*b b*) are set at a little greater than right angle to the base, and the free edges of the side walls are turned inwardly at a slightly greater than right angle to the side walls.

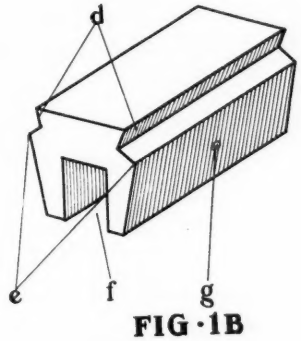
The distance between the edges of these flanges (*c c*) when free is a little greater than the width of the base of the block, Fig. 2 *B*. This guides the seating of the block.

A block, Fig. 1 *B*, whose length is the same as that of the matrix, has its sides disposed angularly, and in its upper corners grooves (*d d*) are provided.

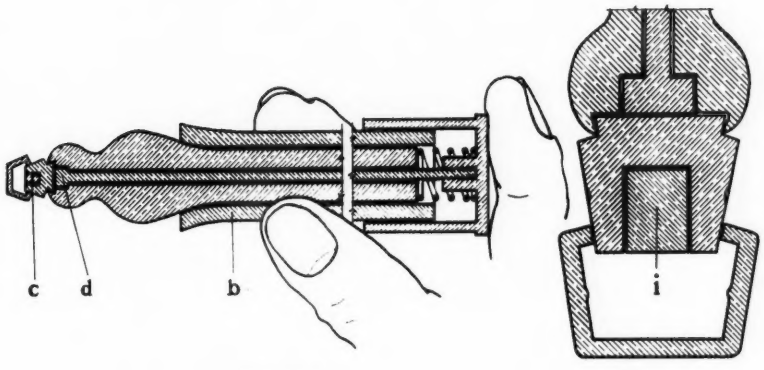
The outer angles of these grooves with the side walls (*e e*) are slightly greater than a right angle to the side walls, and also greater than the angles of the flanges of the matrix, Fig. 1 *A* (*c c*). Likewise, the side walls of the block are at a slightly greater angle than that of the sides of the matrix. This causes the walls and lips of the matrix to grasp the block tightly when it is seated therein. The angles formed by the grooves in the block being so nearly at right angles to the sides thereof, and the base of the matrix being narrower than the width across the block from one groove to the other, it follows that any outward pull applied to the block tends to tighten the grasp of the side walls and flanges upon it, up to the tearing limit of the metal composing the matrix.



FIG·1A



FIG·1B



FIG·2A FIG·2B

The block is prevented from slipping out of the matrix laterally by minute indents on its sides, and corresponding bosses on the inner sides of the matrix, Fig. 1 *A* and *B* (*g g*).

On the under side or base of the block a rectangular channel, Fig. 1 *B* (*f*), runs lengthwise of it. This channel is of the same dimension sectionally as the cross-section of the arch wire intended to be used if root movement is desired, Fig. 2 *B* (*i*). But if tipping or dragging of any tooth is desired, it may be accomplished by using a block with a larger channel so that the arch wire lies free in it.

To facilitate manipulation of these attachments an applicator tool, Fig. 2 *A*, is provided. The applicator is grasped by the thumb and middle fingers much

as a pen might be held, and brought to clasp the block at the grooves by bearing down the sliding sheath, Fig. 2 *A* (*b*), with the thumb and fingers. It is carried to the mouth, the channel of the block fitted over the arch wire, Fig. 2 *A* (*c*); the sliding sheath of the handle, Fig. 2 *A* (*b*), is lifted up by a slight movement of the fingers and thumb, which releases the block from the grasp of the applicator while it is still being pressed into the matrix by the rod, Fig. 2 *A* (*d*), depressed by the first finger to complete the seating.

Unfortunately this may sound rather complicated, but it is really quite simple.

Release of the attachment is effected by applying pressure at either end of the block and sliding it out of the matrix laterally. For teeth which are entirely out of line and the space partly closed, a special short block is provided for use until the space can be opened by use of a coil spring over the arch wire.

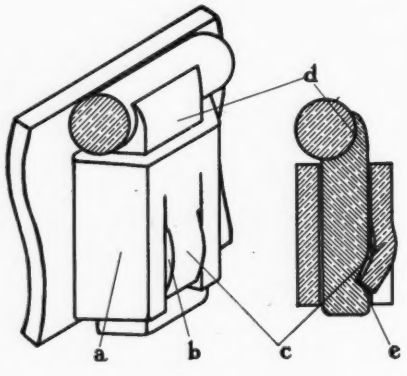


Fig. 3.

PALATAL OR LINGUAL LOCK

In the alignment of malposed teeth by means of the fine gauge labial arch wires, provision should always be made for stabilization of the anchorage teeth. For this purpose a palatal or lingual arch of 0.040 gauge is used, and for its attachment an improved lock is provided. This lock is designed with a view to simplicity, ease of manipulation, security of hold, and freedom from tendency to catch and hold particles of food or otherwise irritate the gingivae.

It consists of an angularly shaped tube, Fig. 3 (*a*), made of an elastic material such as clasp gold soldered to the anchor band in the usual manner. The wider side of the tube is placed against the band. The narrower side has two slits (*b b*) extending from its gingival end to near the occlusal end, thus leaving the middle portion of that wall free to form a tongue (*c*) which is bent slightly outward in its middle portion and inward at its free end.

The base wire or arch has attached to it a shaft (*d*) shaped to fit into the tube and long enough to extend slightly beyond it. At a point corresponding with the end of the tongue of the tube an angular groove (*e*) is placed transversely across the narrower side of the shaft. The arch is applied by inserting the free end of the shaft into the occlusal end of the tube, and by pressing it

home, the free end of the tongue springs into the groove and holds it securely without recourse to loops, ties, or other gum irritating means. Removal is easily effected by applying pressure at the gingival end of the shaft either by a pointed instrument or by means of a plier such as the Bach shaft removing plier.

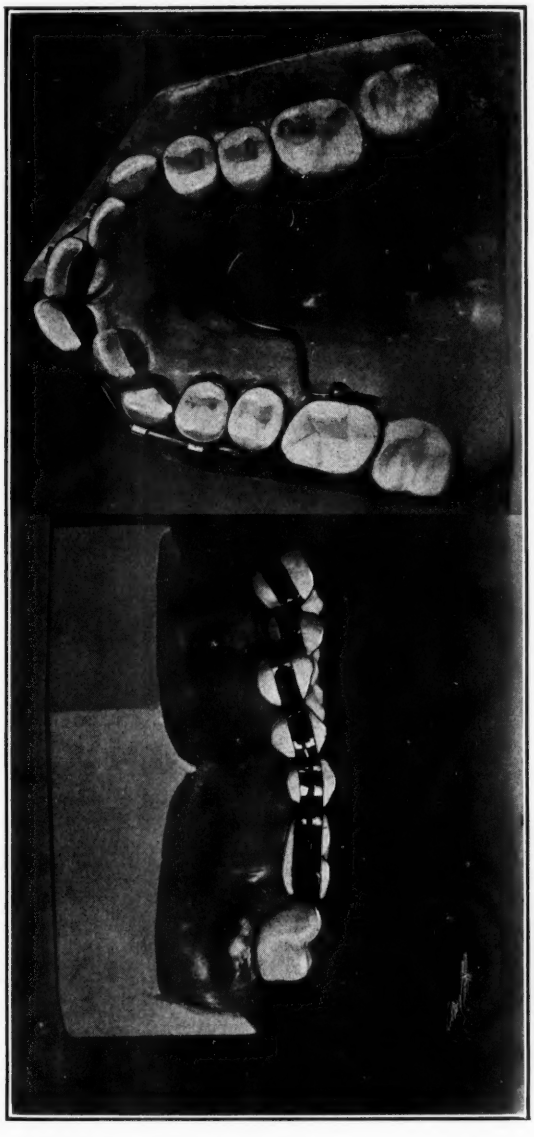


Fig. 4.—Lateral and palatal views of appliance mounted on model.

This lock overcomes the tendency to catch food experienced with most other locks, and in the two years that I have been using them there has never been a break nor accidental release.

RESPONSE TO ORTHODONTIC TREATMENT*

ROBERT CUTLER, M.R.C.S., L.R.C.P., L.D.S., LONDON, ENGLAND

THIS is virtually a Class I irregularity, with marked narrowing in the maxillary intercanine region and consequent gross misalignment of the maxillary incisors; a further small complication is the lack of eruption of the right second mandibular incisor, the deciduous counterpart being retained.

Fig. 1.—Commencement of treatment, April, 1933.

Fig. 2.—Continuation of treatment test, 1934.

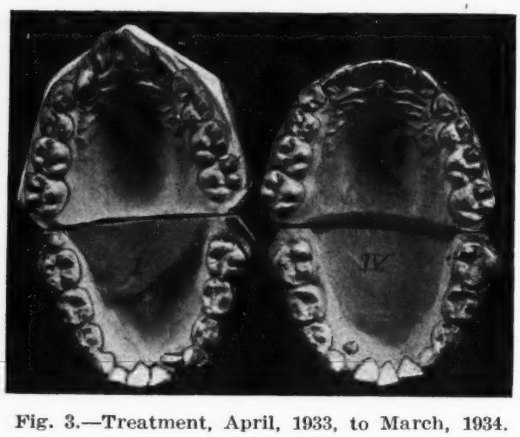


Fig. 3.—Treatment, April, 1933, to March, 1934.

It will be noted further that the crowding in the maxillary premaxillary region is reflected in the mandibular, the left mandibular second incisor being inlocked in its attempt at eruption.

Treatment was commenced on April 19, 1933, a simple maxillary expansion appliance, with sharp anterior biting incline being employed, a simple lingual

*Transactions of British Society for the Study of Orthodontics, 1934.

arch of Mershon type being fitted in the mandibular arch. For the first four months the maxillary appliance was worn all the time, i.e., day and night, and at meals, expansion and automatic alignment of the incisors proceeding steadily, while the anterior incline acted efficiently on the instanding mandibular incisor.

After four months a new maxillary appliance, identical in type to the former one, was inserted and was worn during the day and at meals only, while the retained mandibular right deciduous incisor was extracted, the gum over the unerupted permanent tooth being boldly cut away under a local anesthetic.

At present the maxillary incisors are in very fair position, but expansion at a fair rate is continuing in both jaws to allow room for the right mandibular incisor to assume a good position, as it will be noticed that it is now appearing through the gum.

Between April 19, 1933, and the present time, eleven visits only have been paid, but already I must say that I feel relieved of much of my responsibilities in respect of the patient's welfare.

This case, I think, illustrates the tremendous value and utility of the Badcock expansion alignment appliance, if carefully and correctly used, despite the arguments of those who claim that it is incapable of stimulating bone growth; and furthermore, how the use of such an appliance can be most charmingly combined with a lingual fixed mechanism in the mandible.

Advocates of extraction, too, could hardly hope for a speedier resolution of the symptoms of irregularity, which first drew the attention of the parents to the need for treatment.

Department of Dentistry for Children

DENTISTRY AND THE CHILD

HUGH MCCALL DANIEL, ATLANTA, GA.

PSYCHOLOGISTS would have us believe that a child born of man has only two original fears, a fear of falling (sudden loss of support) and a fear of loud noises; but many parents will swear that psychology has overlooked the most troublesome fear of all—the fear of the dentist's chair. Why this dread of the dentist's chair by the child? Since he was not born with it in his little mind, it must have been acquired by association with the chosen few who make up his entire universe. At a time when his mind and body are growing apace, every stimulation which enters his mind—whether by sight, hearing, feeling, taste, or any other of the senses—has a profound influence upon his development. The effect may not become apparent for months or years; but it is incorporated in the child's make-up, nevertheless. That is precisely how little Johnny learns to dread the dentist. Father has delayed going for many, many months; and, when finally driven to it by a toothache, he does not hesitate to say how much he dreads going.

Why, only last week Mr. McWhipple nearly had blood poisoning after a particularly putrescent tooth was removed. Mother sympathizes with father and feels compelled to add her tale of woe, just because she knows that misery loves company and that perhaps father will feel slightly better for knowing that he is not alone.

Of course mother and father are sensible, well-educated people, and this feeling of dread is more like the shudder that precedes a dose of castor oil than anything else. They know that dentistry is not a holdover from the Spanish inquisition, that it is a real healing science which is doing much to increase human comfort and happiness; but do they present that side of the picture to little Johnny? They do not! Instead, if the subject comes up during a lagging conversation, they always must say something which has to do with pain, blood, swollen faces, or Mrs. Tweedlebaum's unsuccessful efforts to keep her plates from clicking, and so on. Parents do not realize that such statements, dropped during a casual conversation while a child is present, can create an unreasoning fear in the child's mind, which will have to be contended with even after he has become an adult.

Now it is admitted—without question, of course—that dental care is just as important as medical care, life insurance, marriage, and such essentials of the normal life; and that little Johnny must get his share of these essentials because they are good for him. Why is it so often true that the things that are good for us always taste bad, have a morbid color, or are in some way very unattractive? Take spinach, for example.

Yet we are born with only two dislikes, or fears. The rest must be the result of improper education, and, when we say education, we do not refer to the school alone. Johnny is being educated—and how—while he takes in that rigmarole of pain and fear that father thoughtlessly recites in his presence. Do you not see, the mental processes and developments of the young child have only recently come to the front? Why, child psychology was unheard of twenty years ago. In grandpa's day "children were to be seen and not heard," according to the copy-book maxim, and many the antisocial habit that children developed because of this.

Use right psychology in bringing the child to the dentist, and do not wait until the day before to begin your propaganda. As your child grows old enough to take in what is being said around him—the age when secrets must be spelled out—casually bring dentistry into the topics of conversation in a favorable light. Speak of wanting to visit the kind doctor, not dreading it. Dwell upon the bright side of the visit and do not mention pain. Soon the little fellow will be begging you to take him to see Dr. Smith. Take him. Take him often and regularly, and he probably will never know the pain of abscessed teeth and extensive cavity preparation because all his dental troubles will be headed off by simple, preventive methods before they can progress that far.

For example, deep fissures in the back teeth are particularly susceptible to decay because they are not self-cleansing. The crown of a molar might be likened to the crown rolls that mother used to bake. Each roll is formed from three smaller pieces of dough which are pressed together before baking, producing a crownlike appearance on the top of the roll. After baking, the three small sections can still be distinguished, and the roll breaks between them. Analogically, the molar crown develops from five different lobes, or parts, which grow individually and at the same time fuse together. If this union is faulty, deep cracks or fissures will be left between them just as in the case of the roll. The cleansing action caused by passage of masticated food over the tooth surface does not reach them because they are so deep and narrow. Usually, these fissures or faults can be made self-cleansing by polishing them so that bacterial plaques, the chief forerunner of decay, cannot form in them because they are brushed off by an avalanche of fibrous food particles passing over the surface. That is why dentists tell you to eat more coarse foods; because they perform this cleansing action so much better than do such foods as white bread, eggs, oatmeal, etc.

In dental restorations, as in any other mechanical device, the simpler forms are most perfect and efficient. There has grown up a myth in the minds of a large group of the American public that no matter how bad off your mouth gets, the dentist is a magician who can easily make it just as good as new. A nice compliment to the dental profession, but not true. The cause of this idea is, of course, due to the great strides in restorative art which the profession has developed in the past twenty-five years. Why the need of such extensive restorations? Simply because the last generation was not taught to apply the ounce-of-prevention rule to dental care. As a result, the dental profession now has two problems before it: first, to repair the ravages of neglect in the mouths of the past and present generations; and, second, to do preventive work for the next generation that they may be more fortunate than we.

If modern trends are any indication, the child of the future will far surpass the child of yesterday and today in his achievements because he will be better equipped to cope with the problems of his age. Child psychology—its importance—is just beginning to be understood. Luther Burbank, while talking of child welfare some years ago, remarked, "If we had paid no more attention to our plants than we have to our children, we would now be living in a jungle of weeds."

Most parents have a very hazy idea of the dental mechanism and do not at all understand the importance of deciduous (to fall off from) teeth in the scheme of things. A usual attitude is, "Oh, those are his baby teeth; why bother with having them fixed when he is going to lose them anyhow?" Hardly better is the parent who takes Junior along to wait in the office while father has his teeth fixed, and then after the doctor has finished with him, suggests that the last few minutes of the appointment be utilized by letting Johnny hop in the chair for a "once-over."

"Just look over Junior's mouth, doctor, before we go."

What an injustice to Junior, when his mouth requires all the time and care and thought that the conscientious dental practitioner can give it. Parents should not underrate deciduous teeth, for they are very important. They prepare food for the child's digestive system during the period of rapid growth and development, the period of life when the individual is most susceptible to infectious diseases and therefore needs the utmost of health and resistance to help ward off such menaces as diphtheria, chickenpox, measles, and others. It has been stated by one of the Mayo brothers, that about 90 per cent of all diseases enter the body through the mouth, the one part of the human anatomy that the dentist has spent years of study and practice learning how to keep in health and free from trouble. Parents would be highly indignant and insulted if told that Junior was unclean and ill groomed, but they take such a mouth condition as a matter of course.

"Why, Junior brushes his teeth every day!" they say. True enough, but an individual cannot, over a period of time, keep his mouth fit without the aid of a dentist. Deposits form on inaccessible surfaces of the teeth where the brush does not clean. Bacterial plaques which remain on a tooth for as long as forty-eight hours require more than a simple brushing to remove them. These plaques are simply clots of mouth bacteria which are tied down over a roughened spot on a tooth or overhanging margin of an improperly finished filling by a sticky, viscid substance called mucin which is derived from the saliva. The plaque hardens and forms a protective coating over these enemies of tooth structure.

Patients, their minds in a quandary after reading about the phantoms of modern advertising such as "pink toothbrush" and "dental cripples," often inquire which dentifrice is really the best. It is not the toothpaste that counts, it is a correct brushing technic together with good old elbow grease that does the work. The paste just makes the occasion taste better.

One of the most important rôles played by the deciduous teeth is that of leaders or guides for direction of the erupting permanent teeth. They each have a special function to perform in this respect, and also each has a specific shedding time; that is, when they should loosen and come out. This time varies be-

tween individuals, sometimes as much as a year or more, but an index as to their condition can be obtained from a chart of average shedding times which has been worked out by observation of thousands of individuals. Just as much harm can be done by retaining a deciduous tooth too long as by premature loss. These two happenings are the chief causes of malocclusions. This means literally a bad or abnormal bite of the teeth. Normally, each biting surface has a corresponding surface in its opposing tooth against which it contacts or occludes when the mouth is closed. In a bad bite, one or more of these surfaces in one or more teeth contact the wrong surfaces in the opposing teeth. The effects of this condition vary as to the extent and type of malocclusion; but usually facial symmetry is disturbed as well as the ability to chew food properly and to pronounce words correctly.

The first permanent molars are probably the most publicized teeth of the oral apparatus, and yet laymen in general do not fully understand their importance. Most mothers mistake these teeth for deciduous teeth because no baby teeth are lost when they erupt, since they erupt behind the entire deciduous arch. Such being the case, they get the same neglect that is bestowed upon the deciduous teeth. There are four first permanent molars, one on each side of both maxillary and mandibular arches. They are well erupted before any other permanent tooth appears upon the gum line. Now why did the great designer of all things plan for these teeth to occlude ahead of all others, if not to hold the jaws in their right relationship during the time when the baby teeth are being replaced by the permanent or succedaneous ones? If they were not in position, all semblance of occlusion would be lost. That is why, more than anything else, it hurts a dentist to see a little fellow lose this first permanent molar because of extensive destruction by decay.

If adults cannot chew properly without a full complement of teeth, then surely children cannot do so either; but why deny them teeth through neglect simply because they have another set on the way? Decayed baby teeth predispose decay in the teeth to follow.

And now a word about the blessing of orthodontia. This branch of the dental science deals solely with the correction of bad bites—what the dentist terms malocclusions. Teeth are not embedded in the jaw bone solidly. On the contrary, they are each suspended in individual compartments by a fibrous basket or membrane which supports the tooth, supplies it with blood and nourishment, and also provides it with a sense of feel. The tooth can, therefore, give under pressure to a certain extent. If the pressure is harsh, the tooth will be injured; but if a very light, delicate pressure be applied over a period of weeks, the tooth will have time to readjust its support as it moves, and the change of position will be permanent. That is exactly what the orthodontist accomplishes through his ingenious use of springs and the application of the laws of physics. He has spent years of postgraduate study learning why, how, when, where, and how much to move which teeth. There is now no excuse for a child's appearance being marred by protruding teeth.

This is just one phase of the benefit which mankind receives from the newest branch of the healing science. Modern dentistry is, by the way, an American product—the one really great thing that we as a people have yet developed.

If, in spite of all we can do—and that happens in the best of families—a deciduous tooth is lost, we cannot restore function; but we can prevent the arch from closing in on the resultant space and producing a malocclusion, by the insertion of a simple little device called a space maintainer. It is worn until a permanent tooth erupts to fill its space.

One must not get the idea that we deal with each tooth as *a* tooth with *a* hole in it to be plugged up. Instead, we consider the health of the entire masticatory mechanism. To illustrate, I shall ask a question. How many other teeth does the loss of one tooth affect? The answer is, every tooth in the mouth. The teeth on each side of the space previously occupied drift into it, destroying the relation between all the teeth of that arch. The opposing tooth of the other arch elongates or erupts too much, in an effort to find a new plane of contact. Since it is of smaller diameter at the neck, this causes a loss of tension and contact between the teeth of that arch.

What is the cause of dental decay? This is a problem yet to be solved by science. Perhaps, some day, the door of the unknown will be opened a little further, and we shall be able to prevent decayed teeth just as we prevent rabies today. Modern trends of thought are now following two lines of attack, however. Many eminent men think that faulty diet is the cause and cite, as partial proof of their case, the condition of various Indian tribes of the far northwest. Those living in areas remote from civilization, upon the foods of their ancestors, have no decay or pyorrhea; while those who have come in contact with civilization and have learned to prefer modern foods, such as white flour, have much dental disease. The contrast is certainly striking. The other and older theory was the chemicoparasitic theory, evolved by Miller, which set forth that the fermentation of starches and sweets in the mouth produced an acid which ate into the structure of the tooth enamel, exposing the more vulnerable dentin beneath to the inroads of bacteria. The most reasonable attitude, it seems, is that decay is caused by either of these conditions or by a combination of both.

A mother should not forget that the most important feeding time for the baby, so far as his teeth are concerned, is what she eats before he is born; because all the deciduous teeth are already formed at birth. It is reasonable to say that the texture and the soundness of the most important permanent teeth are already determined at birth also.

In summary, I have said a lot about how fear of the dental chair is produced, and how it can be obviated by proper childhood education. I have touched on the value of dental care to the child. Would you not be doing your child a great favor if you taught him the true value and need of dentistry instead of always speaking of pain?

Department of Orthodontic Abstracts and Reviews

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Practical Orthodontia. By Dr. Martin Dewey, revised by Dr. George M. Anderson, St. Louis, 1935, The C. V. Mosby Company.

After fourteen years a new edition of Dewey's *Practical Orthodontia* has appeared, long awaited and expected by many. Often the question was asked why this volume, generally considered the standard textbook of orthodontia, had never been revised and brought up to date by its author. Several reasons were responsible for this, one of them being the specialization taking place within the science of orthodontia.

Since the time when Angle wrote a textbook all his own, setting forth his method of diagnosis, etiology, appliance design, and treatment, an enormous amount of research work had been done in orthodontia. This research produced new developments in practically every field. Through histologic experimentations a great number of pertinent data became known regarding the teeth and their surrounding structures; several important methods of diagnosis were conceived; and the number of new appliance designs became legion.

A book on orthodontia, which is not strictly a textbook for students but a reference book to take the place of Dewey's original volume, must include all these new developments within its pages. Dewey's fourth edition did justice to the requirements of a reference book, for he included in it all important facts known at the time regardless of his own viewpoints and methods, even the pin and tube appliance which he hated so much. This necessitated extensive reference to other authors' writings and the borrowing of illustrations. No doubt, the fifth edition would have had to contend with a tremendous increase in references unless the reviser decided to let some of the major contributors tell their own story, and that is just what Anderson did.

So we find a first chapter, written by Bernard W. Weinberger, painting in a splendid review the historical background of modern orthodontia. This historical review distinguishes itself from other similar attempts not by merely citing names and dates, but by giving a vivid account of the evolutionary steps in orthodontic procedures, etiology, classification, and means of treatment.

The chapter on occlusion retains the fundamental principles which were laid down by Dewey and defended by him sometimes in the face of violent opposition: the forces of occlusion. "These are the forces which, when act-

ing as nature intended, cause teeth to assume and maintain their proper position in the line of occlusion." They are: (1) cell metabolism, (2) muscular pressure, (3) force of the inclined planes, (4) approximate contact, (5) harmony in size of the arches, (6) atmospheric pressure.

Pullen's diagnostic charts are reproduced as a means of better illustrating the different types of malocclusions. Angle's classification is given a prominent place, and the carefully compiled general outline of his intraoral method should make this difficult problem clearer to even the inexperienced student. "It is truly the purpose of classification to determine the degree of deviation and not to indicate the boundaries of treatment."

The etiologic factors of malocclusion are divided into two classes: first, those which are found solely in the mouth and are associated with the teeth; and, second, others which are termed remote or obscure. Despite the fact that, especially in the latter class, there is little agreement in the literature, Anderson maintains courageously the standpoint expressed in the title of the book (*practical* orthodontia) and warns the orthodontist not to be discouraged by this fact. "Much good work has been done in orthodontia with the limited knowledge of etiology at our command." The newer conception of diet as a factor of faulty development of the child is given deserving emphasis in this chapter.

In a further discussion of orthodontic diagnosis, the methods developed after Angle's classification are enumerated and described (though they should logically follow closely the chapter on Angle's classification). The heading of "arch predetermination" includes Hawley's and Gilpatric's charts and F. L. Stanton's pantographic surveying method, the last one in its author's own words.

An appropriate condensation of the pages on impression taking and cast making of the previous edition (which was rather too elaborate) yielded sufficient space to present the technic of making photographic records. Harry Wright recommends a simple and effective method of photography, which can conveniently be carried out in every office and which requires only a minimum of equipment. He stresses the following points: (1) use a good and clean lens, (2) use a dark background, (3) cut down diaphragm to f 16, (4) use supersensitive panchromatic film, (5) standardize development, (6) standardize exposure time.

The chapter in the previous edition on the use of x-ray in orthodontia is replaced in the new edition by an up-to-date description of radiographic examination which includes examination technic, dark room equipment, and unusual findings, such as supernumerary and missing teeth, root resorptions, impacted teeth, and others. To this Sidney Riesner adds an exposition of his technic in making radiographic profiles. The film used is an Eastman duplitized ultraspeed 8 × 10 inch film, placed in a lead backed exposure holder or in a cassette with intensifying screens. The average dental x-ray machine with 45 kilovolts and 10 milliamperes can be used. With 72 inch anode-film distance, the exposure (with two intensifying screens) is two and one-half seconds.

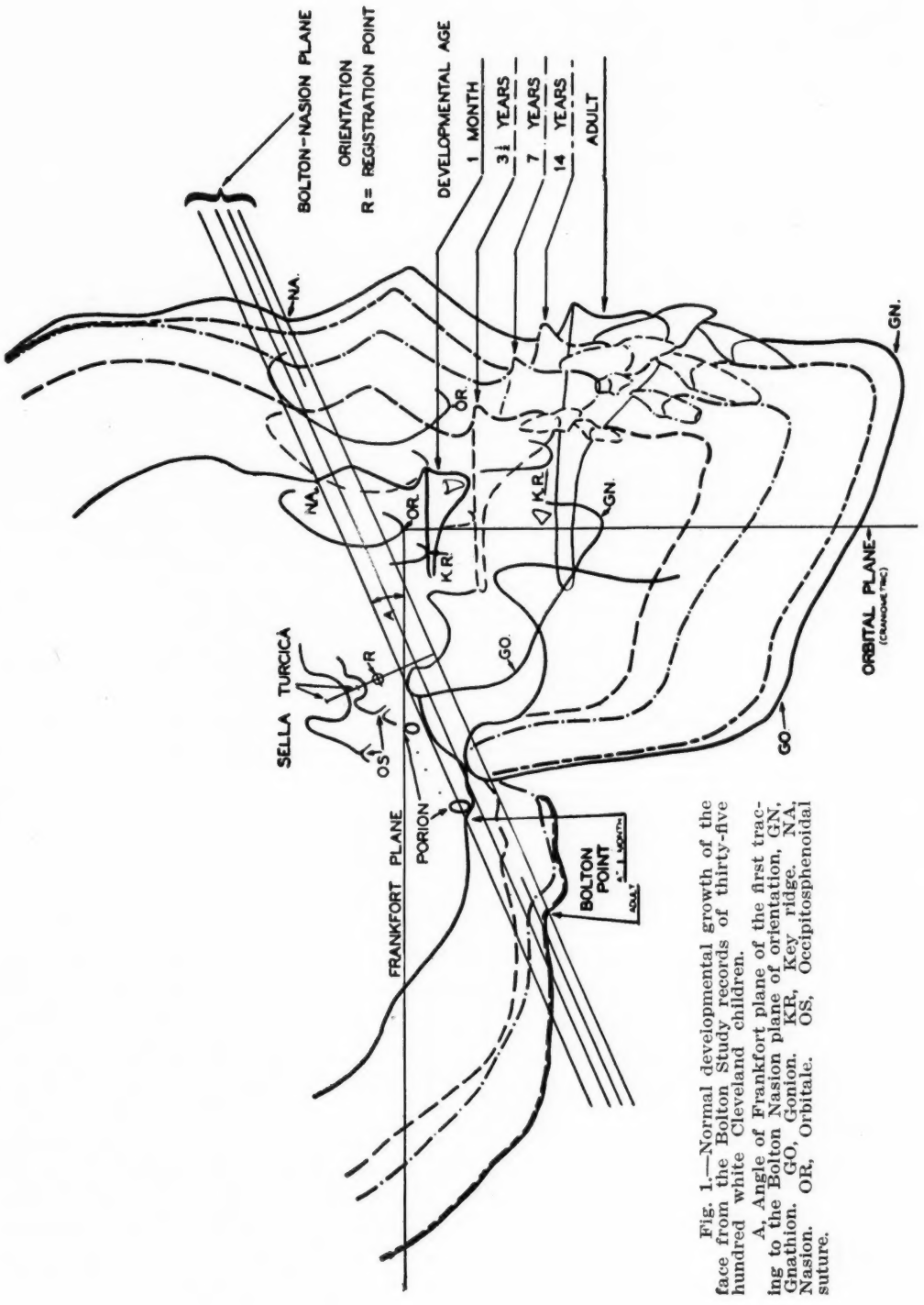

Fig. 1.—Normal developmental growth of the face from the Bolton Study records of thirty-five hundred white Cleveland children.

A, Angle of Frankfort plane of the first tracing to the Bolton Nasion plane of orientation, GN, Gnathion. GO, Gonion. KR, Key ridge. NA, Nasion. OR, Orbitale. OS, Occipitosphenoidal suture.

The topic of orthodontic diagnosis is further enriched by a chapter on gnathostatics and photostatics, which contains the principles of Simon's work. A rather unusual feature is presented by the following chapter, which is entitled, "Measurements of Dentofacial Changes in Relation to the Cranium," written by B. Holly Broadbent. Here we find a scientific consideration of growth and development; we become acquainted with the standards of cephalometric measurements; and we learn of the roentgenographic cephalometer which is more accurate on the living head than any other measuring device. Developmental growth patterns of the faces of children are made with this instrument at regular intervals; from the superimposed tracings, the direction and the amount of facial growth can be studied (Fig. 1). Abnormal developments and malocclusions are examined in a similar manner.

Harry E. Kelsey, as one of the contributors, undertakes to discuss extractions in their relationship to orthodontics. He takes a conservative attitude and believes that our diagnostic methods are not yet accurate enough to predetermine with certainty which case can be treated successfully with the retention of all thirty-two teeth, and which will not respond to such treatment. In Class II cases, especially with young patients, an experimental treatment should be instituted in order to determine whether it is possible to obtain satisfactory results, before considering the alternative method of premolar extractions. The claims of those men who advocate the extraction of the second molars in cases in which there is not room enough in the dental arch for the third molars, Kelsey accepts for the maxillary teeth only, because the mandibular third molars are less favorably situated to erupt into the space of the second molars. (It seems that even the maxillary second molars are not removed without disadvantages. A slight space remaining between first and third molars presents the danger of food impactions; one may also ask the question why—without good reason—a normal second molar should be sacrificed for the sake of a malposed third molar. Furthermore, in all extractions, the change in the occlusal relationship of the teeth should be considered, which may bring about periodontal disturbances.) Kelsey ends his treatise with this résumé: "However satisfactory to the patient, the orthodontist will never experience the same satisfaction that he does in those cases in which he succeeds in supplementing nature's efforts with artificial stimulation of the supporting structures of the teeth, sufficient to provide space for all of the thirty-two teeth in normal occlusion."

The next chapter, a most interesting one, is written by Rudolf Kronfeld on "Tissue Changes Incident to Orthodontic Tooth Movement." In it he evaluates critically the different experimental data gathered by Sandstedt, Oppenheim, Johnson, Marshall, Schwarz, and others; he deals with the transformation of bone, tipping movements, bone changes during retention, results of excessive force, continuous versus intermittent forces, and root resorption.

The rest of the book is devoted to treatment. Radical changes have been made from the previous edition by the elimination of older treatment methods and their replacement with new appliance assemblies. A great number of

diagrams and photographic reproductions of appliances and casts illustrate the text.

The approach to treatment is indicated by comments on the favorable periods of treatment, on early treatment, and on observation. Then the "methods and aids to treatment" lead us to the strictly technical devices: bands, tubes, labial and lingual arches, bite plates, elastics, and ligatures. Laboratory procedures acquaint us with the fundamental rules for soldering, and with the various materials used in appliance design. (Appliance construction from stainless steel wire is only briefly mentioned, though it is known that Anderson is a master in this field. One should have liked to hear in greater detail about this new and promising method.)

Fig. 2.—*A* and *B*, two views of band driving instrument.

The myofunctional treatment of malocclusion is set forth by Alfred Paul Rogers in a special chapter. Such treatment will aid the mechanical appliances. "Mechanical forces alone only partially attain the wished-for result; and if the student is able to think of the muscles as 'living orthodontic appliances,' he should be able, as the years pass, to apply them more and more effectually. He will gradually learn that development brought about by increased function calls for less retentive apparatus than development brought about by mechanical means alone." The most helpful applications are: the masseter-temporal exercise, the pterygoid exercise, the treatment of distoclusion and mesioclusion, the tongue and orbicularis oris exercise.

We now approach the mechanistic treatment of malocclusion, starting with a review of the requirements which appliances must possess, and of the

different types of appliances used. The importance of proper band construction is evidenced by the devotion of a special chapter of twenty-four pages to this subject, written by Earl W. Swinehart. He describes the direct and the indirect anchor band technic in a manner which is impressive by its thoroughness and simplicity. Swinehart deserves grateful acknowledgment for recommending the band driving instrument (Fig. 2) which eliminates painful mallet blows and supplants them with the child's own masticatory pressure, thus making him a partner in the operation.

Among the appliances, the first one described is the labial appliance. "As it is impossible to practice orthodontia without the use of the labial arch, it is vitally necessary to understand the principles of applying the arch in its various modifications." The modification of the simple labial arch is the arch with auxiliary springs, the high labial arch, the pin and tube assembly, and the ribbon arch with bracket bands. The edgewise arch mechanism (its forming and manipulation) is demonstrated by Chester F. Wright.

The development and the use of the removable lingual arch are, by means of an extensive citation, explained in John V. Mershon's, its originator's, own words. He also is cited in a description of its laboratory technic. E. B. Arnold outlines the construction of the coil spring, used to provide a "gentle positive continuous force in orthodontic treatment."

Orthodontic treatment for every one of the various typical and classified malocclusions is discussed in great detail. Besides that, a chapter is added with procedures ". . . . not considered as the only available methods of treatment or even necessarily the best; they are methods and aids, however, which under certain conditions and circumstances have proved useful and usually successful in orthodontic practice." (These procedures would find a more appropriate place in the systematic discussion of treatment.) Whenever necessary, radiographs and actual mouth photographs are employed to illustrate conditions better.

Anderson is of the opinion that the general practitioner of dentistry may attempt certain orthodontic corrections, and he has prepared a list of cases which the general practitioner may "consider for treatment," while another list contains conditions "too difficult for those lacking proper training and experience." (This viewpoint, not shared by many others, including the reviewer, is rather surprising at a time when the orthodontic profession, through the American Board of Orthodontia, seeks to raise the standards of orthodontic training.)

Plastic surgery of the jaws is discussed by Edward A. Kitlowski in the following chapter, which acquaints the reader with the most striking jaw deformities and their correction. Interesting data are presented, especially where surgical and orthodontic treatment are undertaken jointly.

We can realize the advance which orthodontia has made since Angle's publication by the fact that there is probably no one man living today who could write a textbook on orthodontia without the aid of other men. The collaboration of a number of authors has made it possible to present a book which is authoritative in every chapter. That it has lost some of its unity

through the procedure is a disadvantage which cannot be avoided under the circumstances. But it has gained in other respects, and it has maintained the quality of the previous editions, so that at the present time it can be considered the most complete and the most standard orthodontic text and reference book.

The volume contains a detailed index and an abundance of valuable bibliographic references. Five hundred and eighty-six illustrations are used, which are of exceptional quality and clearness. Some of the mouth photographs could be improved by enlargement after cutting down the size of the field itself (for instance, Figs. 34, 59, and 62). The format has been changed to a somewhat larger size than that of the previous editions, which makes for convenient reading and at the same time reduces the bulk of the book.

E. N.

The Forum

Articles for this department should be sent to Dr. Albert H. Ketcham and Dr. William R. Humphrey, 1232 Republic Bldg., Denver, Colo.

Specialty Licenses for Oklahoma

The Oklahoma Dental Society was successful in getting an entirely new dental act passed at the 1935 session of the legislature. It was signed by the governor and became operative on May 2. The act contains some real innovations in dental legislation. It is identified as House Bill 173; an act to create an organization to be known as "The Registered Dentists of Oklahoma"; to provide for its membership, dues, and powers; defining the practice of dentistry and dental hygiene; prescribing rules of admission, professional conduct and prohibiting certain practices; providing penalties for the violation of the provisions of said act; and repealing all other existing dental laws.

The drafting and the introduction of an entirely new dental act were considered advisable, as the Oklahoma laws regulating the practice of dentistry were patterned after those of other states enacted many years ago. In the opinion of the legislative committee and the legal counselors, the old act had grown obsolete in meeting the present-day standards of education and ethics. It, furthermore, restrained dentistry in meeting its social problems. A complete revision was indicated to modernize properly the laws regulating dentistry.

Dental history reveals that the advancement of dental education has been largely dependent upon legislation. The state laws making it compulsory for practitioners to be graduates of approved schools have made it easy to improve the standards of undergraduate education by organized sentiment. In the past, graduate education leading to specialization has not been fortified by legislation and the subsequent moral support it provides for the stabilization of higher education. It is evident that if medical and dental education had been without legal recognition, the advancement would certainly have been slow and uncertain. It was not until these professions became legalized that any really great progress in education was made.

Some of the special features of the Oklahoma Dental Act are attracting national attention. Many of the leading minds along the lines of dental education and legislation have given the provisions of the act considerable study and believe them to be sound.

In the first place, it is unique in authorizing the establishment of an organization wherein all dentists of the state are banded together for the common purpose of law enforcement. The act automatically made every dentist and dental hygienist a member of the organization. Every member is required to pay a small annual license fee of from $2.00 to $5.00, as authorized by the Board, to remain in good standing. This revenue is used to finance the activities of the organization.

There is constituted a Board of the organization, known as "The Board of Governors" of the "Registered Dentists of Oklahoma." The original bill provided that the Board members be nominated and selected by mail ballots. This was amended, and the authority was vested in the governor of the state to appoint the nine members, with the advice and consent of the senate. One is selected from each judicial district of the state. As the Board is granted broad powers in the matter of law enforcement, this places the dentists throughout the state under the watchful eyes of the Board members in their immediate vicinity. This in itself is having a salutory effect in preventing infractions of the law. The Board is charged with the executive functions of the organization and the enforcement of the provisions of the act. The Board has the power to appoint such committees, including examining committee, referees, officers and employees, as it may deem necessary and proper, and to fix and pay salaries and necessary expenses. It further has the power to aid in the advancement of dentistry in all its phases. As an illustration, the Board may appoint investigating and examining committees either within or without its group of members, or in combination, in dealing with examinations and infractions of the law. A variety of disciplinary measures are provided. Complaints are heard by the Board, and the right of appeal goes directly to the supreme court of the state. No provision is made for trial in the intermediary courts.

Those sections of the act which deal with the licensing of the specialties has attracted great interest, especially in orthodontia circles, as it has been without any legal standards.

The section defining the practice of dentistry is very broad in its scope. Among numerous acts designating the practice of dentistry is included, "or takes impressions of the teeth and jaws; or diagnosis, makes and adjusts appliances to artificial casts of malposed teeth in the human mouth with or without instructions." This makes it unlawful for anyone to take impressions and make dentures or to diagnose malocclusion and prescribe treatment unless it be done by a licensed dentist. In addition, there are other restraints. Any member is forbidden from announcing or holding himself out to the public as limiting his practice to, or being especially qualified in, any branch of dentistry, without first having obtained a license from the Board as herein provided.

The Board, upon satisfactory proof that the applicant has had a minimum of thirty semester hours of graduate work in any one of the several recognized branches of dentistry in an approved college or university, or its equivalent to be determined by the Board, may issue a license to such member to hold himself out or to announce to the public that he is especially qualified in, or limits his practice to, or gives special attention to, any one of the recognized branches of the dental profession.

Examinations shall be in writing and shall include all the subjects represented in the different branches of approved graduate schools. Written examinations may be supplemented with an oral examination. Demonstrations of the applicant's skill are also included. A special license is required for the practice of each recognized branch of dentistry in order for the member to hold himself out to the public as limiting his practice to, or being especially qualified in, any

branch of dentistry. The fee for such examination and special license is $20.00. Any applicant failing to pass such examination shall be entitled to take one additional examination for a fee of $5.00. This examination is supplemental to the regular examination required of all applicants for license to practice dentistry in Oklahoma.

The phrase "or its equivalent," as a substitute for thirty semester hours, authorizes the Board to examine members on their professional record to determine whether, in the opinion of the Board, the applicant has acquired in knowledge and skill the equal of thirty semester hours graduate instruction as provided in the approved colleges. Every member of the "Registered Dentists" organization is privileged to practice any and all branches of dentistry without obtaining special licenses so long as he does not represent himself as defined within the act. The reader will find in the provisions relating to specialized practice that all practitioners of dentistry are prohibited from representing themselves as specialists in the classified section of telephone directories and other media, unless they hold a specialist's license.

It is designed to establish legal standards for admission to practice the specialties that coordinate with the educational standards being established by the colleges and universities. According to the modern concept of education, dentistry can no longer afford to look with satisfaction upon the proprietary schools and apprenticeship system as meeting the American standards in education for specialization.

The act, like all other state laws regulating the practice of dentistry, prohibits all false and misleading advertising and such other overt acts as would lead to the exploitation of the public and other dental practitioners.

The reader should observe that commercial orthodontia laboratories are in effect outlawed in Oklahoma. In the first place, any such laboratory would have to be manned with licensed dentists operating under their own name. In the second place, they would have to obtain special orthodontia licenses and in addition comply with the code restraining advertising, for such methods as they use are specifically defined as the practice of dentistry and the specialized practice of orthodontia.

This act is effective only within the state and does not affect interstate commerce, but the racketeering of orthodontia in its different phases will be choked to death just as rapidly as other states pass this type of legislation.

The special features of the act relating to orthodontia and the licensing of the specialties were before the dental profession for seven months and before the legislature for four months. During this time none of these provisions were ever attacked by members of the profession or of the legislature. It apparently was the consensus of opinion that they were fully warranted and a desirable thing to have.

Sixteen practitioners have secured specialist's licenses in the different branches since the law became operative; eight in orthodontia, three in periodontia, four in exodontia, and one in prosthodontia. There is every indication that these special features of the act are proving highly satisfactory.

T. W. Sorrels.

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Editorial

New Mouths for Old

> "I have no more qualms about the value of teeth-straightening. The game is surely worth the candle. When work is done by a skilled operator, I am sure that discomfort can be held to a minimum, and real strain altogether avoided except in the most extreme cases, when the results will justify the strain. I feel toward this rebuilder of mouths much as people in Aladdin's time must have felt toward the man who went about giving 'new lamps for old.' Only now the slogan is, 'New mouths for old.' And I say, more power to the genii who give them to us!"

Thus ends the last paragraph of a very commendable article entitled "New Mouths for Old" by Hubert V. Coryell in the October, 1935, issue of *Good*

Housekeeping. The article merits editorial comment for several reasons: first, because this JOURNAL has received many letters from subscribers commenting favorably upon the article; second, because it is unusual that the subject of orthodontic treatment is presented to the layman through the lay press so understandably as in this article; third, because the author apparently is interested in child life and child welfare; and fourth, because for a layman he has an unusually broad concept of the orthodontic field.

Scientific medicine affords an excellent example of what can be done for the human race. After all, how little its astounding progress is appreciated by the layman, largely on account of his lack of education or information as to what has happened. Even professional men do not realize that the death rate per thousand in 1880 was approximately 20 per 1,000 people annually in the United States and that at the present time it is about 11 per 1,000 population. This reduction has been accomplished in a large measure by an enormous drop in the mortality rates for infants and children and in lesser degree by increased control of such diseases as yellow fever, typhoid fever, tuberculosis, hookworm, and the like. Thousands of people are sick and dying because medical knowledge and scientific progress are not well understood by many and are rather clumsily applied.

There is an inability to apply both medical and dental knowledge with the same precision which produces it. Orthodontic education like medical education is an excellent thing for the layman when it is well done.

H. C. P.

In Memoriam

John Lewis Walker, Sr.

1856-1935

On his father's plantation, Rose Hill, near Boydton, Mecklenburg County, Virginia, on March 1, 1856, John Lewis Walker, one of nine children, was born to Judge James Toy Walker and Mary Ridley Blackwell Walker.

He died of coronary thrombosis at his home in Norfolk, Virginia, on September 6, 1935, following an illness of six weeks. Interment was in the family plot at Blackstone, Virginia.

When, in his early teens, Rose Hill was disposed of, as were many of the old Virginia homes that suffered during the Civil War and the reconstruction period that followed, the family moved to the ancestral home of his mother in Lunenburg County, Virginia. Spending his boyhood and early youth on the farm, he received his early education in private schools and under private teachers.

In 1882, at the age of twenty-six years, he went to Texas, where he was employed by the Texas Express Company, then by Wells, Fargo and Company's Express, as railway express messenger, running out of San Antonio far into the southwest cattle country. It is not known what gave him the inclination to study dentistry, but returning home from Texas he went to Chicago in April, 1890, where he enrolled for the "Spring Course of Lectures and Infirmary Instruction" at the Chicago College of Dental Surgery. Completing the spring course at Chicago, in the fall of 1890 he entered the Baltimore College of Dental Surgery, which he attended one full session, and after which, funds being low, he returned to Texas with his college instruments and equipment to practice dentistry. Back in Texas he first opened an office in the little town of Timson, then in Henderson, from which he made trips to outlying localities by horseback, carrying in a large saddlebag his instruments and equipment.

He practiced in Texas for almost three years and was appointed a member of the Texas Board of Dental Examiners by the Hon. W. J. Graham, judge of the Fourth Judicial District of Texas; but, as he returned to Baltimore in the fall of 1894 to complete the course in dentistry, he did not serve on the Texas Board. The year of 1894-95 was spent at the Baltimore College of Dental Surgery, from which he received his D.D.S. degree on March 21, 1895, and was awarded the first prize in operative dentistry at the commencement exercises.

Soon thereafter he went to Norfolk, succeeding Dr. W. H. Ginrich, and was engaged in the general practice of dentistry for eighteen years, during which time he enjoyed one of the largest practices in the state and made an enviable reputation as a practitioner. In 1913 he attended the opening session of the Dewey School of Orthodontia in Kansas City, and, on returning to Norfolk on the completion of this course, limited his practice to orthodontia, which he ac-

tively practiced until the time of his last illness. For a few years after specializing, he maintained an office in Roanoke for orthodontia and spent five or six days a month in that city.

In 1897 he was married to Mary Chappel Bagley, daughter of William Edward Garland Bagley and Julianna Pegram Trotter Bagley, of Lunenburg County, Virginia.

Dr. Walker was a member of the American Dental Association, was past President of the Virginia State Dental Association and of the Virginia Tidewater Dental Association, and a member of the American Society of Orthodontists and of the Southern Society of Orthodontists. He served on the Virginia State Board of Dental Examiners and was for a number of years its secretary.

He is survived by his widow and three daughters.

In the death of Dr. Walker the dental profession has lost a most loyal and beloved member; one who was ever willing, even in his last days, to share his part of any burden that meant progress and upbuilding of the profession. He was very modest and retiring in manner, but a wise counsellor, especially to the younger men who called on him for mature advice. He always adhered strictly to a code of ethics that was born within, and to know him well was to appreciate more fully his sincerity of purpose. He was a man of strong convictions, but was just in every thought and deed; a loving husband and father, who never gave himself a thought when the welfare and happiness of his family were a factor.

To have been associated with him in the daily walks of life will ever be treasured by his many friends as a sacred heritage.

News and Notes

Southern Society of Orthodontists

The meeting place of the fourteenth annual meeting of the Southern Society of Orthodontists has been changed from the Signal Mountain Hotel to the Patten Hotel in Chattanooga, Tenn., on January 27, 28, and 29, 1936.

WILLIAM P. WOOD, JR., Secretary
442 W. Lafayette Street
Tampa, Florida

Chicago Midwinter Meeting

The Chicago Midwinter Meeting will be held at the Stevens Hotel, February 17 to 20, 1936, inclusive.

Tennessee State Dental Association

The next meeting of the Tennessee State Dental Association will be held in Memphis, May 11, 12, and 13, 1936, at the Peabody Hotel.

J. FRANK BIGGER, President,
Medical Arts Building,
Memphis, Tenn.

E. J. JUSTIS, Sec'y-Treas.,
Exchange Building,
Memphis, Tenn.

Dental Society of State of New York

The sixty-eighth annual meeting of the Dental Society of the state of New York will be held May 12-15, 1936, at the Waldorf-Astoria Hotel in New York City.

A cordial invitation is extended to all ethical dentists to attend the sessions.

Further information may be obtained by writing to:

DR. CHARLES M. MCNEELY, President
1 Nevins Street
Brooklyn, N. Y.

DR. A. P. BURKHART, Chairman Program Committee
57 E. Genessee St.
Auburn, N. Y.

Chicago Dental Society

The Educational Committee of the Chicago Dental Society announces that its third series of educational reprints will start on December 1. The series will run from December, 1935, to July, 1936, inclusive, and will consist of eight educational articles, covering various phases of dental health, but principally stressing the benefits and economy to the patient of regular dental care. As is well known, these illustrated, short articles are written in simple language, free from technical terms, and present the message of dentistry to the public in a manner to make it attractive and interesting to lay readers.

They are first published in the Bulletin of the Chicago Dental Society. Reprints are then made in large quantities and distributed to those who subscribe to them, who, in turn, send them monthly to their patients. They can be mailed singly or enclosed with ethical communications, such as statements, personal notes or business cards. Of course, they also can be dispensed to patients at the chair.

These reprints present an ethical means of contact with patients, which has received the official approval of the Chairman of the Judicial Council of the American Dental Association. Many dentists have found the use of these reprints beneficial in practice and have noted definite instances in which patients have returned after a longer or shorter period of absence as a result of the contact thus maintained. The reprints have been used throughout the United States and Canada, with a total distribution of about half a million copies.

The subscription privilege is open to all members of the American Dental Association. Application blanks can be obtained by addressing the Educational Committee of the Chicago Dental Society, 30 N. Michigan Avenue, Chicago, Illinois.

F. VAN MINDEN, Chairman of Educational
Committee of the Chicago Dental Society